NATURE

No. 4145 SATURDAY, APRIL 9, 1949 Vol. 163

CONTENTS

	Page
...ection Methods and Man-power	545
...ncepts of Culture. By Lord Lindsay of Birker	547
...ate in India. By Prof. J. H. Hutton, C.I.E.	548
...ctical Electronic Circuits for Industry. By T. H. Flowers, M.B.E., ...nd Dr. J. R. Tillman	549
...thematics for the Engineer. By F. G. W. Brown	550
...ne of Taste. By Dr. J. H. Kenneth	550
...ntral and East African Water Resources. By W. D. Brind	551
...form of German Higher Education in the British Zone of Occupa...tion. By Dr. Ronald Fraser	552
...romycetin: its Structure and Synthesis. By Prof. H. Raistrick, ...F.R.S.	553
...ology as a Factor in Taxonomy	554
...bituaries:	
Mr. P. Bruce White, F.R.S. By Sir Charles Harington, F.R.S.	556
Capt. G. C. Shortridge	556
Prof. Douglas Hay	557
Mr. John Ardagh. By Dr. J. Ramsbottom, O.B.E.	557
...ws and Views	558
...tters to the Editors:	
Determination of Carbonic Anhydrase Activity.—A. M. Clark	562
Effect of Urethane Combined with X-Rays on Chick Fibroblasts.—Edith Paterson and Mary V. Thompson	563
A New Method for Determining the Weight of Cellular Structures.—Dr. A. Engström and B. Lindström	563
Chlorophorin, a Constituent of Iroko, the Timber of *Chlorophora excelsa*.—M. F. Grundon and Prof. F. E. King	564
Formation of Trivalent Cobalt Complexes in Protein Hydrolysates.—Per Laland and Karl Closs	565
A Quinonoid Structure for Hydroquinone Pyridinium Salts of Organic Acids.—Dr. Abdel Fattah Aly Ismail	565
Clathrate Compound Formed by Benzene with an Ammonia-Nickel Cyanide Complex.—H. M. Powell and J. H. Rayner	566
Double Orientation and Infra-Red Dichroism in Polymers.—Dr. A. Elliott, E. J. Ambrose and R. B. Temple	567
Reactions in Liquid Sulphur Dioxide.—Dr. I. Lauder and E. Rossiter	567
Determination of Keto-Acids by Partition Chromatography on Filter-Paper.—Dr. Doriano Cavallini, Nora Frontali and Giovanni Toschi	568
Divergent-Beam X-Ray Photography.—W. May	569
Radioactivity of Dust.—C. Jech	570
Raman Spectrum of Potassium Bromide.—Prof. R. S. Krishnan and P. S. Narayanan	570
Differential Transformer Bridge Operated by Square Waves.—Dr. W. A. Prowse and Mrs. Elizabeth Laverick	571
Free Barium in and Evaporated from Oxide Cathodes.—R. O. Jenkins and R. H. C. Newton	572
A Simple Method of Producing Wide-Band Frequency Modulation.—Dr. H. Rakshit and N. Sarkar	572
Studies on Human Dentine.—H. F. Atkinson and Prof. E. Matthews	573
Mutations by Photodynamic Action in *Bacterium prodigiosum*.—Dr. R. W. Kaplan	573
Artificial Media for Rearing some Phytophagous Lepidoptera.—Eunice F. Wellington	574
A Fungus Disease of Raspberries Induced by Insect Attack.—R. S. Pitcher and P. C. R. Webb	574
Biological Oxidation of Manganous Sulphate in Soils.—V. B. D. Skerman and S. M. Bromfield	575
A Narwhal in the Thames Estuary.—Dr. F. C. Fraser	575
...Microscopic Localization of Minerals in Skeletal Muscle by ...ternal 'Micro-Incineration' within the Electron Microscope. By ...r. M. H. Draper and A. J. Hodge	576
...Teaching of Biology in Schools. By Prof. H. Graham Cannon, ...F.R.S.	577
...ucture of the Resting Nucleus in *Marasmius androsaceus* Fries. By ...r. J. A. Macdonald	579
...location for the Lewis and Lutheran Blood-Group Systems	580
...Teaching of Physics. By G. R. Noakes	581
...atic Races of *Achillea*. By Prof. I. Manton	582
...ury Grants for Science and Research in Great Britain	583

Editorial and Publishing Offices

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

...phone Number: Whitehall 8831

Telegrams: Phusis Lesquare London

Advertisements should be addressed to

...Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2

Telephone: Temple Bar 1942

...nnual subscription rate is £4 10 0, payable in advance, inland or Abroad

...ights reserved. Registered as a Newspaper at the General Post Office

SELECTION METHODS AND MAN-POWER

IN its ninth report for the session 1947–48, the Select Committee on Estimates discussed the Civil Service Commission, and recommended that the Civil Service Selection Board should be retained for the present, if only on a part-time basis. Few who saw the Board at work in its country mansion at Stoke d'Abernon were not impressed by the skill and thoroughness with which the potentialities of candidates were probed and brought to light for the final interview board of the Commission. It is not contended, even by those who hold most strongly that the new methods have helped the final selection board to make a better selection and fewer mistakes, that these methods are as yet anything more than experimental, and it should not be forgotten in applying them that their effectiveness depends largely on the accuracy with which we can define the qualities sought in the candidates, whether for the Civil Service or any other occupation.

Nevertheless, granted that the Selection Board has been working on the right lines—and there were only two dissentients from this view on the Select Committee—the Civil Service Commissioners have wisely decided to continue the Board on a more modest scale. They agree with the Committee that when the present lease of the Manor House at Stoke d'Abernon comes to an end, smaller and less expensive premises should be found. So far as the Civil Service itself is concerned, the number of candidates is likely to be considerably reduced in the near future. Therefore the Commissioners agree generally with the Committee that there should be a reduction in the directing staff; but they observe with some force that the extent of the reduction should be determined on general grounds of economy and administrative efficiency, rather than in strict proportion to the decline in the number of candidates as the Select Committee suggests. To effect a substantial reduction the Commissioners believe that a non-residential establishment is necessary, and candidates will accordingly have to find their own accommodation while under scrutiny. Certain consequential changes in the arrangements operated by the Selection Board will be necessary, which will coincide with the conclusion of the main series of examinations under Reconstruction Regulations; but no estimate of the resulting savings in cost is given. At the same time, the Commissioners record their emphatic opinion that a residential centre affords the best conditions for the conduct of the Selection Board experiment, and they do not accept the view that the work which has been done at Stoke D'Abernon has been an unnecessary extravagance.

These decisions of the Commissioners are announced in the third report from the Select Committee on Estimates for the session 1948–49*. They are accompanied by a spirited reply to some of the observations in the ninth report referred to above. The Commissioners challenge the Committee's con-

* Third Report from the Select Committee on Estimates. Pp. 87. (London: H.M. Stationery Office, 1949.) 4d. net.

clusion that the system of testing tends as a whole to favour candidates who are quick at dealing with intelligence tests but who may lack some of the qualities especially valuable to the Government service. The Commissioners insist that, at the final group conference, at which all the evidence is marshalled and weighed by the three judges, no single piece of evidence is decisive and that speed at dealing with intelligence tests is only one small factor, and one of the less important, among a very large number that are taken into account. In answer to the comment that the Colonial Office does not make any use of the procedure at Stoke D'Abernon, the Commissioners remark that the India Office and Burma Office in 1945 set up a board on the same lines to test candidates, and the Admiralty, War Office and Air Ministry are using a similar system to test candidates for cadetships.

It is true that it will be some time before the recommended candidates show their powers of development, so that there is at present lack of full evidence on which to judge the merits of the system for selecting candidates. Meanwhile, even the Select Committee admits that many first-class recruits might be lost to the Civil Service if the method of entry by way of Stoke D'Abernon were to be abandoned. The promise which the innovation has shown suggests, indeed, that the Board might be entrusted with more experimental work, and the decision to restrict its work may, from the national point of view, prove a false economy in that it may deny to industry and the universities the opportunity of learning from the Board something about choosing applicants.

In his evidence before the Select Committee, the First Commissioner, Sir Percy Waterfield, said that a joint committee with the Federation of British Industries was exploring the possibility of putting the Selection Board's methods at the disposal of industry. He also referred to the suggestion, which has since received wider publicity in the report of the 'working party' on university awards, that the Selection Board could be used to help to sift young ex-Service conscripts who, for some reason or other, failed to qualify for a university education before they went into the Forces, but have been reported on favourably by their Service education authorities. On the first statement the Select Committee made no comment; but on the second, it "would view with concern the adoption of a system as a result of which only those applicants possessing qualities thought to be desirable in a Civil Servant would be accepted by the Ministry of Education as suitable for a University education".

Surely, however, the first principle of selection tests is to define the qualities sought in candidates. The Commissioners have rightly made clear that a new form of tests appropriate to the purpose would be worked out by the Civil Service Selection Board, in conjunction with the Ministry of Education and the university authorities, the object being to select those candidates who possess qualities likely to enable them to profit by a university education. Whatever the precise form these tests take, the Selection Board would presumably submit a report to the appropriate authority, and it would be for that authority to reach the final decision, using the report as evidence. It is true that Dr. W. W. Grave made reservations on this point in the 'working party' report, but he does not seem to have misunderstood the proposal as the Select Committee appears to have done. Dr. Grave was concerned to preserve the autonomy of the university and the right of the university to make the final choice of applicants from those who might be recommended by a selection board. It should be noted that the working party's proposal was to place the final responsibility neither with the selection board responsible for the tests nor with the universities, but with a Final Selection Board constituted by the Ministry of Education, on which the universities were to be represented. This is quite a different proposal from that now suggested by the Civil Service Commissioners, which should go far to meet the objections from the universities' side to that in the report on "University Awards".

In any event, it is made perfectly clear that the experiment would be on a small scale until experience has been gained. The great administrative strain under which the universities are at present placed is a further reason for experimenting with any method that may help to relieve them in what may be an increasingly heavy task, quite apart from the desirability of trying out new methods of finding the nation's most promising talent for a university education. Most important of all is the task of finding ways to assess a candidate's potentiality rather than his achievements, and no solution to that problem will be found without experiment and much careful thought.

Whether or not the methods of the Civil Service Selection Board can be modified and applied so as to make a real contribution to the selection of even one type of university student, they may well offer some real help in the selection of men for industrial appointments, and perhaps especially for administrative responsibility. The result of the inquiry to which the First Commissioner referred will be awaited with interest. In the meantime, the observations on the possible application of such selection tests to candidates for university awards may contribute to the discussion of the wider question of university examinations, which has been brought to a flux by the new examination system to come into full operation in 1951. In reconsidering entrance requirements, whether by examination alone or with the further assistance of selection tests or the interview, the first step is for the universities to be quite clear as to what they are looking for in their candidates for admission.

This step is fundamental in formulating any proposals to give effect to the resolutions passed at a recent meeting of representatives of universities convened to discuss proposals for entrance requirements and to harmonize divergent views. However strongly it may be agreed that greater weight must be given to diligence and aptitude, or that the possession of intelligence and zeal, as Sir Henry Tizard

urged at the Brighton meeting of the British Association, is what matters most on entering the university, the universities cannot well consider the matter apart from the schools. A thorough understanding between the universities and the schools is essential in shaping the entrance examination, just as a thorough understanding of what we seek for in candidates is the first condition in devising effective selection tests to guide us in the choice of entrants for the Civil Service, for industry, or possibly for the university awards and scholarships as well.

The whole problem of selection is a highly important aspect of the general problem of man-power. No method that promises to assist in discovering the nation's precious resources of talent, and in placing it where it can best develop, is to be regarded lightly as uneconomic. One great difficulty in assessing the value of an institution such as the Civil Service Selection Board is that while its financial cost is so easily determined, the return to the nation is much more intangible and may, indeed, only appear over a period of years.

CONCEPTS OF CULTURE

Notes Towards the Definition of Culture

By T. S. Eliot. Pp. 124. (London : Faber and Faber, Ltd., 1948.) 10*s.* 6*d.* net.

THIS is a puzzling book. It begins with Mr. T. S. Eliot explaining that his intention is definition, that he wants to make clear to his readers what culture is, and what it is not, to give us a better understanding of the meaning of the word so that we shall not talk the nonsense about culture of which he complains.

The first chapter is devoted mostly to this, and is called "The Three Senses of 'Culture' ". I find this chapter quite extraordinarily difficult to understand. What seems to emerge as a fairly simple point is that culture properly so called is a characteristic of society as a whole, and that it can be applied to groups and individuals in so far as they play a part in the culture of the whole. Secondly, that the culture of a society is, at least to some extent, a growth and therefore unconscious, and not something that can be consciously planned. We can see that certain tendencies in society are inimical to culture, or tend to degrade it, and we can deal with these specific evils. But culture as a whole we cannot plan. Mr. Eliot then goes on to talk about the relation between culture and religion, warning us that the word 'religion' has got to be understood with great care. About this he says : "The way of looking at culture and religion which I have been trying to adumbrate is so difficult that I am not sure that I grasp it myself except in flashes, or that I comprehend all its implications". Which reminds me of the famous remark of Tennyson about Sordello, that he only understood the first and the last lines. Mr. Eliot seems to mean that the culture of a society is its whole way of life, and so is its religion, and yet they are not the same ; and I give this up, because I less understand what Mr. Eliot means by religion than what he means by culture.

I do not think the obscurity of the first chapter matters very much, any more than does the obscurity of the prelude to "The Egoist". In the remaining chapters Mr. Eliot is putting forward certain views about culture which are clearly important and well worth considering. The second chapter is called "The Class and the Élite", and is largely devoted to a criticism of the views of Dr. Karl Mannheim. Indeed, much of the book is a criticism of Dr. Mannheim's passion for planning. As Mr. Eliot says in the last chapter : "one thing to avoid is a 'universal' planning ; one thing to ascertain is the limit of the plannable". Those of us who knew and discussed sociological questions with Dr. Mannheim have probably had something of the same experience which has affected Mr. Eliot. Dr. Mannheim's talk was so illuminating, so able and stimulating, that he was difficult to resist, and we often gave up the argument, silent but not convinced, and then went away to ask ourselves hard why we did not really agree. Dr. Mannheim held that the culture of society depends upon an intellectual élite, and that the future of a planned society depends upon the strength and the vitality of this élite. Mr. Eliot's second chapter is really an examination of the whole ideal of a classless society ; that is, a society which is so contrived that every individual fulfils the function for which he is by nature most fitted, where his position in society does not depend on his family or anything of that kind ; there is in the classless society complete and perfect equality of opportunity. We often accept that ideal as an obvious one. Mr. Eliot's criticism is that it is an atomistic view of society, that culture depends at least partly upon the strength of the family and of tradition, and therefore on the existence of classes. We so take for granted nowadays that a classless society is an unmixed good and the ideal towards which in different ways we are all moving that this criticism of the ideal by Mr. Eliot seems to me of great value. Whether one agrees with it or not, the considerations which Mr. Eliot brings forward are well worth thinking about.

The third chapter is called "Unity and Diversity : The Region". Mr. Eliot's contention is that it is very important that the culture of a society should have in it a certain unity in diversity, and that is admirably fulfilled in a society which has both dominant and satellite cultures. He explains why, in his view, it is a good thing for English culture that it is in relation with and affected by Welsh and Scottish cultures, as it is good for Welsh and Scottish cultures that they are not entirely independent, but are affected by English culture. Therefore it is important to preserve the vitality and independence of the satellite cultures, and it is worth agreeing to political and economic arrangements which will subserve the partial independence of such satellite cultures. The vitality of a culture depends upon its relation to other cultures and is served by a certain friction between them ; and this is what really matters in regionalism in general. "It is an essential part of my case, that if the other cultures of the British Isles were wholly superseded by English culture, English culture would disappear too." Then Mr. Eliot refers again to his previous chapter, stressing the vital importance for a society of friction between its parts. "One might even put it that a classless society should always be emerging into class, and a class society should be tending towards obliteration of its class distinctions. I now suggest that both class and region, by dividing the inhabitants of a country into two different kinds of groups, lead to a conflict favourable to creativeness and progress." It follows from this that the

ideal of a world culture is a bad ideal if it means the disappearance of local or national cultures. "The zealots of world government seem to me sometimes to assume, unconsciously, that their unity of organisation has an absolute value, and that if differences between cultures stand in the way, these must be abolished."

The fourth chapter is a discussion of the same problem of unity in diversity in religion, with, as one might expect, an interesting criticism of the ideal of the reunion of the Christian Churches. "I am much concerned with the danger that reunion facilitated by the disappearance of the cultural characteristics of the several bodies reunited might accelerate and confirm the general lowering of culture." The fifth chapter is a note on culture and politics, which maintains that our excessive pre-occupation with politics and with planning, and thinking out the nature of society, is inimical to culture. "We are encumbered not only with too many new books: we are further embarrassed by too many periodicals, reports and privately circulated memoranda. In the endeavour to keep up with the most intelligent of these publications we may sacrifice the three permanent reasons for reading: the acquisition of wisdom, the enjoyment of art, and the pleasure of entertainment." The chapter contains a very interesting criticism of what Mr. Eliot calls a modern political theory, the real data of which are impersonal forces, and which is occupied with humanity only in the mass.

The sixth chapter is a criticism of modern theories of education, and especially of the notion that culture can be produced by education, and re-affirms the general criticism of the danger of planning with which the book as a whole is concerned.

When I first read Mr. Eliot's book I was so troubled by the obscurity of the first chapter that I found it difficult to persevere with the rest of it; but I have, I hope, made clear there is in all the chapters after the first a great deal of illumination and wisdom which makes this book well worth reading and pondering over.

LINDSAY OF BIRKER

CASTE IN INDIA

Caste in India

A Bibliography. Compiled by William H. Gilbert. Pp. 174. (Washington, D.C.: Government Printing Office, 1948.)

THIS very important contribution to the study of caste consists of 174 folio pages of typescript, of which the last 85 constitute the bibliography proper, the first 89 constituting introductory matter, including an essay on "Some Aspects of Hindu Caste" which is perhaps more important even than the bibliography, and that in spite of a number of errors and omissions. For example, it is stated (p. 25) that there is no alphabetical index for the castes of Bombay on the lines laid down in the 1901 census, but Enthoven's (1920) "Tribes and Castes of Bombay" (No. 99 in the bibliography) was the outcome of the work of compilation started in 1901; meanwhile, the Baroda State issued in 1912 a glossary of "Castes, Tribes and Races in the Baroda State", compiled by G. H. Desai, which covers the bulk of the castes to be found in the Bombay Province, but does not seem to appear in the bibliography. In any event, the author does not seem to appreciate the extreme difficulty of preparing an accurate return of caste from people of whom a considerable proportion have a definite interest in misrepresenting their real status. Again, castes scarcely ever claim an origin in a common ancestor; to describe *pravara* as an extension of the lineage is in a sense correct but very inadequate; 'caste-marks' painted on the forehead refer not to the caste of the individual wearing them but to his religious sect; the comparison with the United States and the interpretation of the rigidity of caste distinctions as based on the colour bar in India are extremely doubtful, as is the fanciful identification of different *varna* with different races. The Aryan-speaking invaders contained Kshatriya, Brahman and Vaishya within their own ranks, though they doubtless recruited from indigenous invaders and incorporated later ones like the Scythians and Huns. An inadequate knowledge of India is glaringly betrayed by a writer who speaks of the monsoon as falling in the winter to the east of Benares and prevailing in the summer to the west of that town.

But in spite of several passages which are fanciful, and even foolish, in this essay, it contains a very great deal that is valuable, and forms a suggestive and important contribution to the study of caste. The bibliography, which exceeds 5,000 references, suffers from its inclusiveness, since it is virtually impossible to tell what is important and what is worthless. It is true that the references are classified, but this has not always been very accurately done, and in many cases, of course, such classification must be extremely difficult. At the same time, it is surely an error to put Aiyappan's monograph on the Nayadi among references in periodicals, because it appeared as a bulletin of the Madras Museum, instead of in §8 with studies of single castes; and his monograph on the Iravas does not appear at all. Northey and Morris's "The Gurkhas" appears in §8 on the other hand, as though the Gurkhas were a single caste, instead of in §9 (*g*) under Nepalese caste, where it should be. Bhattacharya, dealing with caste all over India, appears in §7, whereas Blunt, dealing specifically with northern India, appears in §1 on the "Caste System in General". All reference to the brilliant Baluchistan census report of 1911 by Sir Denys Bray is omitted, as indeed all other census and gazetteer information from Baluchistan; there is no reference to the 1927 edition of Senart ("Les Castes dans l'Inde") or to its English version; Ketkar's first volume was published at Ithaca, N.Y., in 1909 to be sure, but the second was published in London in 1911; Dalton's "Descriptive Ethnography of Bengal" would be better placed among "Studies of Castes by Geographical Areas" (§7) than among "Works in General—Studies of Regions, etc., with Caste Included"; Gait's "History of Assam" should probably have been included in §13, "Histories with Caste Data", and Mackintosh's "Account of the Ramoosies" (Bombay; 1833) in §8; Day's "Land of the Permauls" (Madras; 1863) and Mateer's "Land of Charity" (London; 1871) should be included in §15, "Studies of Regions with Caste Included"; and Knox's "Historical Relation of the Island of Ceylon" (London; 1681), Part 3, should have been included either in §9 (*j*) ("Ceylonese Caste") or in §11 ("Early Travellers and Caste"); Bateson and Mead's "Balinese Character", if it is to be included at all, should probably have gone into §9 (*i*) on "Balinese Caste", but, like many other works included, its bearing on caste is very slight.

Criticisms of this sort, however, are very easy to make and must not be taken as intended to detract from the value of the great labour which has gone to this important compilation. They are made here rather towards the improving of the ultimate form that this bibliography must have, for it is much too important to remain comparatively inaccessible in the limitations of typescript. It is something which no one has previously attempted, and the undertaking might well daunt any scholar from a repetition.

J. H. HUTTON

PRACTICAL ELECTRONIC CIRCUITS FOR INDUSTRY

Handbook of Industrial Electronic Circuits

By John Markus and Vin Zeluff. Pp. xv+272. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 39*s*.

THE compilers of this handbook have selected some four hundred and forty electronic circuits from published literature, mostly from *Electronics*, of which they are associate editors. For each circuit there has been compressed into an average of little more than half a demi-quarto page a circuit diagram, including the values of all the important components, a general circuit description, and some discussion, which according to the type and complexity of the circuit may include the performance to be expected, points where special care or accuracy is needed or difficulties are likely to be encountered in making up the circuit, and suggested applications of the circuit. A reference to the article in which the circuit originally appeared is given. For ease of reference the circuits are grouped under twenty-two different chapter headings, each is cross-indexed many times in a subject index, and there are also page order and author indexes. The emphasis of the work is essentially on the practical side of industrial electronics, the chief purpose of the handbook being stated in the preface "to provide a busy engineer with a ready source of information about the circuits he needs for a particular industrial electronic application".

The reader is assumed to have some considerable familiarity with the subject. The chapter headings serve only to divide up the circuits into groups. No introduction is given which, by way of theoretical discussion, would clarify concisely the characteristics and main problems of each group. Each circuit stands by itself without relationship to, or obvious continuity with, any other circuit except for a rough progression from simple to more complex circuits within each chapter. It is in this respect that one doubts whether the handbook presentation is the best way of achieving the stated purpose. For example, if not previously informed, the reader would have to do a considerable amount of study of the handbook before he gathered that drift is the main problem of D.C. amplifier circuits. The absence of quantitative data on the amount of drift to be expected with the several circuits described would leave him in some doubt as to which would best suit his purpose. The busy engineer is well served if he wants to make one apparatus to do a particular and well-understood job, and he can find just the circuit he wants, or one which needs very little modification. To those for whom these conditions seldom apply—and the British engineer may have difficulty with the American components even if the conditions do apply—the main value of the work is that of a study book, a secondary object according to the compilers but the more important in the opinion of the reviewers. No collection of circuits of the number and origin of these could fail to have educational value to engineers in all sections of the electronics industries; to engineers in other industries it serves as an introduction to the possible uses of electronics.

The audio-frequency circuits cover a wide range of problems. Many of the cathode ray circuits would be easier to understand if wave-form diagrams were included with the circuits. The counting circuits given should cover most requirements except for resolving times of a microsecond or less, which are perhaps not yet industrial. The better known quenching circuits for Geiger–Müller counters are omitted in favour of a more complex circuit, the resolving time of which is not stated. Many noise-reducing limiter circuits for radio receivers are described; but no good relative assessment could be made without a study of the original articles. The measuring circuits are varied, and many should prove useful in production testing. The limitations of the instruments using these circuits are not usually given, so that a user who just copies the circuit runs the risk of an unsatisfactory result, a risk which runs all through the book in one form or another.

There is a whole chapter on metal-locating circuits, which seem sound enough even if of limited interest. Mechanical rigidity should not be overlooked in assessing the ease with which the operator uses the equipment. Multivibrators, more easily described qualitatively than quantitatively, are helped by wave-form pictures on the circuit diagrams. The oscillators described cover a wide range of frequency, wave-form, flexibility and power output. Some border on precision, some are useful for production and servicing, and some for producing radio-frequency power for radio-diathermy or industrial heating. Reactance tube control in an elementary form is used in two circuits.

The photo-electric circuits described emphasize the wide uses of light-sensitive cells in industry. The circuits are in the main of the simpler types, though some undoubtedly have finer points which need appreciating if the utmost sensitivity, stability and accuracy are to be obtained.

The chapters on various kinds of control circuits will interest the industrial user in the less obvious application of electronics. The telemetering circuits range from the control of model ships to that of guided bombs. A wide range of timing circuits is given, including resistance-capacity, clock and ballistic timing elements, but counting cycles of a standard frequency is not mentioned as a timing means in either the timing or counting sections; this is a serious omission. The few ultrasonic circuits given are mostly concerned with echo-sounding.

The scope of the circuits will be gathered from the foregoing paragraphs. That omissions are mentioned is not to be taken as indicating a poor selection of the circuits; the best selection is naturally very much a matter of opinion. The claim that the ninety per cent of circuits from *Electronics* and ten per cent from about twenty other journals approaches a representative selection from all published literature is, however, open to severe criticism. The editing is satisfactory on the whole; the diagrams and descriptions are clear; the discussions, though useful,

are limited by space and are frequently not critical or analytical enough—often in the original as well as the abstract—for the limitations to be adequately appreciated. There are some surprising lapses, however, in the editing. On p. 14 there is a phase reverser that does not reverse phase, and on p. 47 an over-voltage relay which has no operating circuit, both being faithfully copied from the originals, probably by using the same blocks. Casual examination showed that Brunetti and Greenough, represented by a useful circuit on p. 28, are not in the author index.

The handbook may be recommended for what it is—a collection of practical circuits among which an engineer with a particular problem may find a ready solution, but is more likely to gain ideas which will lead to a solution.

T. H. Flowers
J. R. Tillman

MATHEMATICS FOR THE ENGINEER

Applied Differential Equations

By Prof. F. E. Relton. Pp. viii+264. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1948.) 20*s*. net.

AT the joint session of Sections A (Mathematics) and G (Engineering) of the British Association meeting, held last September, it was stated in a discussion on "Applicable Mathematics" that "Mathematics is an integral part of engineering science evolved to satisfy the demands of the science, and should be used by the engineer as one of the tools of his trade"; and later in the discussion the point emerged that "the engineer's main difficulty lies in the translation of his engineering problem into mathematical terms, and then, on finding a solution, in translating that solution into an engineering solution". Commenting upon this, a later speaker stressed the desirability of the enlightened teacher of mathematics being able to speak the engineer's language. There should be very little difficulty about this, for the modern trend of much mathematical literature is to produce books having a practical bias. Thus the old artificial barrier between academic mathematics and the more modern mathematics applied to the sciences is gradually being broken down.

Probably few subjects have more applications than differential equations, for they enter into the foundations of most sciences, especially engineering in all its branches. In the volume before us, we have an introduction to the subject, characterized "by a frankness of expression unusual in text-books". This readable text quite lucidly covers equations of the first order, linear equations, miscellaneous theorems and methods (devoted chiefly to geometrical considerations and first-order equations of a degree higher than the first), simultaneous equations, Fourier series, partial equations, the method of isoclinals, numerical methods of solution, equations in three variables and equations with variable coefficients. While each of the eleven chapters is well provided with exercises and illustrative problems, the book ends with a good set of miscellaneous exercises, hints and answers with an index.

If it is asked: How does the book justify its title?, the answer will vary with the point of view. Quite frankly, the number of real practical applications seemed at first to be disappointing, but on going through the exercises set for the student, it was discovered that many standard applications were included. These, with the hints given later, should prove very valuable. The text throughout is excellently written, and the author's style is to be commended. The subject seems to be treated with just as much rigour as is essential for a practical student's intelligent use. The book should certainly be useful to a conscientious student and seems to form a good introduction to the same author's "Applied Bessel Functions".

F. G. W. Brown

SENSE OF TASTE

The Taste Sense and the Relative Sweetness of Sugars and other Sweet Substances

By Prof. A. T. Cameron. (Scientific Report Series, No. 9.) Pp. ix + 72. (New York: Sugar Research Foundation, Inc., 1947.) Free.

INTEGRATION of knowledge relating to the chemical senses is hampered not only by an extremely scattered literature but also by the rarity of the synthesist who is a specialist in all the different fields of science involved, and who is able to appreciate the presence and significance of the lacunæ which mark stages in the process of integration. A monograph on the sense of taste, written by a distinguished biochemist versed equally in physiology and chemistry, is therefore of exceptional interest, by no means lessened by its special reference to sweetness. The applications of Prof. A. T. Cameron's investigations are of particular value to food technologists, and it is fitting that this work should have been published in the noteworthy Scientific Report Series of the Sugar Research Foundation.

Following a summary and brief introduction, the author admirably surveys the anatomy and physiology of taste, and then proceeds to a discussion of the variability of taste perceptions in different individuals, the relationship between the chemical constitution and tastes of organic compounds, and the taste sensations other than those of sweetness. The second part of the memoir deals with early work on the sweetness of sugars, and includes, in more detail, a discussion of the results of Dahlberg and Penczek (New York State Agric. Expt. Sta. Tech. Bull. No. 258; 1941) as well as of the author's own experimental research.

Finally, Prof. Cameron directs attention to a number of problems needing investigation: possible histological differences in the taste-cells corresponding to the four primary tastes, the relationship of the sour taste to chemical acidity, the sweetness of mixtures, and cognate subjects for inquiry. A new suggestion resulting from his own work is that the intensity of taste-perception due to stimulation of 'sweet' taste-cells by a sweet solution may be modified by other, even tasteless, stimuli.

The value of this monograph is further enhanced by an author index and by a bibliography which, though by no means exhaustive, provides 118 useful references. It is sad to reflect that Prof. Cameron did not live to see the publication of his outstanding contribution to the science of taste, or to derive satisfaction from the further investigations it will undoubtedly engender.

J. H. Kennett

CENTRAL AND EAST AFRICAN WATER RESOURCES

A REPORT* dealing with the water resources of Central and East Africa has recently been prepared by Prof. F. Debenham, professor of geography at the University of Cambridge, after a stay of about eight months in Africa at the suggestion of the Colonial Office. This report, which will be considered by Colonial Governments, is about 110,000 words in length; not only is it a most readable discussion of water-resource problems, but also it throws a strong light on problems of economic and social change. The area covered includes the Bechuanaland Protectorate, Northern Rhodesia, the Nyasaland Protectorate, Tanganyika Territory, Kenya and the Uganda Protectorate.

Only the main points of the report can be presented here, and as the recommendations for action on the public-utility scale are of far less immediate importance than those for action at village-level, the power and river-navigation aspects will be briefly dismissed. The plateau topography and waterfalls which guarantee great reserves of water-power have always prevented bulk transport between the coast and the interior. Because future development depends on transport, all forms of which are scarce, the fullest use must be made of certain waterways, and recommendations are included for surveys of seasonal depth, feasibility of canals, etc.

In the provision of domestic water—the first priority—and water for stock and crops, there are difficult problems, mainly human. Most of the area is under strongly seasonal rainfall; and during the months—or weeks—of the rains, the water floods away to waste, whereas, in the subsequent drought, stream flow falls to a trickle or even vanishes below the surface, leaving a 'sand river'. Man, beast and plant suffer severe strain, and the most intense water pollution prevails. Conditions can be greatly improved along countless tributaries by trapping a fraction of the flood flow behind a series of rock or earthen check weirs, each one 100–200 yards upstream of a village. 300,000 gallons should carry a village of 100 persons and 100 cattle through 200 days of drought. To lessen water-borne diseases, the dam and reservoir might be enclosed from man and stock by thornbush. Water would flow ceaselessly from the reservoir by pipe or furrow to the villagers' watering point, then spill on a few yards to the large washing pool and finally to the stock pool and the river bed. In the sand rivers, one subsurface dam, made by trenching across the valley to the clay bed and nearly filling the trench with clay, can hold up to hundreds of thousands of gallons, according to site. A village could construct its weir or subsurface dam within a few weeks. Porous stream beds usually imply a pastoral economy, and the economic feasibility of piping water from mountain streams deserves study over considerable areas. In streamless regions, boring or well-sinking are the alternatives, and surveys of the ground-water level are needed. Such methods offer the *chance* of health, of increased productivity, population and trade—the chance of rising above subsistence-level.

However, all plans may fail through apathy in the villages. Prof. Debenham points out that there are two refractory problems: the villagers "have a reasonably ordered life, now free from warring, and there is no particular urge to make it easier, or to make it pay better"; further, the unattracted mind sees a bore hole, for example, as "an entirely Government structure" and feels for it "the minimum of responsibility". Progress in these areas awaits countless simple constructions, understood, made by, felt for and maintained by Africans; and the hope must be that African activity will spread from villages which have been induced to try the methods, and where an incentive to increase earning power exists because tastes have been acquired for consumer goods made available by increased production and trade. The establishment of training courses for Africans in the simpler constructions, and even in site selection and the simpler uses of water for village power, is strongly recommended. Trained men would supervise new works under local authorities or Government, or in their own villages. Demonstration water-treatment schemes, which Africans from similar areas could visit, are also required.

Treatment of the swamps so common in the wetter areas is discussed at length. The valley swamps are natural steadiers of flow and their complete drainage would be disastrous. The recommended forms of simple partial drainage under European supervision would, in numberless valleys, provide new farmland and would localize more water in ponds. The major swamps, offering enormous volumes of water which now evaporate, all require elementary surveys involving simple mapping and measurement of discharge, depths, levels, etc.—simple but extensive work which already-burdened local officers cannot undertake in years, and without which very little can be started. Prof. Debenham's recommendation—not, of course, limited to swamp surveys—is that scientific expeditions should be encouraged of up to half a dozen young surveyors, engineers, biologists, etc., not yet fully embarked on their careers. A single such party, under a local specialist officer, could, very cheaply and in much less than a year, provide data enabling a general appreciation of the potentialities and treatment needs of the Okavango swamp, as large as East Anglia, or of the irrigation potentialities of several smaller areas.

The report, concerned mainly with problems of water already arrived in valleys or basins or at the ground-water level, and not with the same water while still in or on the soil, only briefly discusses research into water-development problems, which "at first sight . . . seem to be the whole duty of the individual territories". The functions of the African central research bodies are seen, however, to include co-ordination of climatological work, survey promotion, transmission of information between the territories, and much-needed specialist studies such as of the relative evaporation-rates from swamp and open water. However, because land use, operating through the soil and its plant cover, considerably affects the amount and location of water resources, the research required may well be much more extensive and complicated than the report suggests. African land use, especially in areas capable of supporting crops and the denser populations, will change greatly even if gradually, and the effects of these changes on water behaviour can be determined only by long-term studies in selected experimental areas.

* Report on the Water Resources of the Bechuanaland Protectorate, Northern Rhodesia, the Nyasaland Protectorate, Tanganyika Territory, Kenya and the Uganda Protectorate. Colonial Research Publication No. 2. By Frank Debenham. Pp. 85. (London: H.M. Stationery Office, 1948.) 10s. 6d. net.

Again, it may be desirable that conditions in a selected series of valleys or sand rivers should, both before and after treatment, be kept under continuous physical and chemical study.

The report is a most welcome production; one would be happier about its general circulation if a shorter version of the whole were available, somewhat along the lines of the author's paper "The Water Resources of Central Africa" in a recent number of the *Geographical Journal*. The conclusions and decisions of the Colonial Governments and the Colonial Office concerning its implementation will be awaited with the liveliest interest in many lands.

W. D. BRIND

REFORM OF GERMAN HIGHER EDUCATION IN THE BRITISH ZONE OF OCCUPATION

THE Commission set up in the spring of 1948 by the British Military Governor, Sir Brian Robertson, through his educational adviser, Mr. Robert Birley, to examine the problem of the reform of the German universities and technical high schools in the British Zone of Occupation, has published its report*. The membership of the Commission, under the chairmanship of Dr. H. Everling, director of the German Co-operative Society, rested on a wide basis of pedagogic, social and intellectual representation; and in addition to the ten German members, the Commission included Lord Lindsay and Prof. J. R. de Salis as non-German members. The member representing the scientific disciplines was Prof. C. F. von Weizsäcker, of Göttingen.

The Commission had complete freedom of action and of expression, and it has produced a correspondingly valuable report, with a long and carefully formulated list of practical recommendations. The keynote of the report is the definition given of what, in the unanimous opinion of the Commission, the goal of higher education should be, namely, "The teaching of truth in the service of the people, of truth won always through a scientific investigation of the facts"; and the report emphasizes that the three operative words in this definition are: the people, investigation and teaching.

Four chief recommendations follow on the practical level: (1) greatly increased facilities for study for students of limited means; (2) promotion of a more intimate contact between the universities and technical high schools and all classes of society (as also the Ministries of Education) through two new advisory or administrative bodies, the 'Hochschulbeirat' and the 'Hochschulrat'; (3) an increase in the scope and in the numbers of the teaching body; (4) furtherance of education and of the unity of culture through a 'studium generale'.

These reforms, in particular (1) and (3), demand increased funds for higher education; and the Commission unanimously and explicitly stresses that the possible argument that Germany cannot afford these luxuries under present conditions is false. The report makes the point that any outlay contemplated under the reforms recommended must be a very small percentage of the total State expenditure; that on the most mundane level one has to recognize that the fundamental discovery of to-day is the technical application of to-morrow; that, however, the scientific investigation of facts is a unified discipline; and, finally, that any one branch of scientific investigation must wither if the whole tree of knowledge is not healthy.

The report devotes special chapters to the four chief recommendations listed above.

(1) Even allowing for the working-class fear, explicitly admitted in the report, that students from the working-class, once having entered a bourgeois university, might desert their class rather than influence their new environment, nevertheless the Commission is unanimous in insisting on the desirability of the entry to higher education being made dependent on merit and capability alone, and not on means. Further, the importance for students of making practical contact with life within their chosen profession, while still *in statu pupillari*, is stressed, not only in the scientific and technical faculties, but also everywhere where a student in the latter end must have contact with the people, be he pastor, lawyer, economist or medical practitioner. Here the Commission recognizes the danger that faces German scholarship in particular of an unsymmetrical absorption in theoretical principles divorced from life.

(2) It is recommended that attached to each university and technical high school in Western Germany there should be: (*a*) a 'Hochschulbeirat' or advisory committee, widely representative of the life of the community, meeting at least once yearly under the chairmanship of the rector; the 'Beirat' would be purely advisory, its chief aim being to maintain contact between university and public opinion; (*b*) a 'Hochschulrat' or administrative council, charged with the administrative affairs of the university or technical high school, opposite the Ministry of Education in the 'Land' responsible for the university in question. Each 'Rat' would have six voting members—two elected by the 'Hochschulbeirat', two by the Senate, two by the Ministry of Education—none of whom should be paid servants either of the Ministry or the university; and three non-voting members—an official of the Ministry of Education, the rector, and an elected representative of the teaching body. The 'Rat' would be steered by a president, appointed for life by all nine members of that body.

(3) With regard to increasing the teaching body in size and scope, by far the most important recommendation is for the foundation in each faculty of every university of new positions carrying a purely pedagogic assignment and responsibility—'Studiendozenten' and 'Studienprofessoren'. The report admits quite freely that the Commission is recommending here a break with the Humboldt tradition of *Lern-* and *Lehr-freiheit* of the nineteenth century in the German universities—a tradition which the report nevertheless recalls with pride. These new teaching posts would carry the status and privileges of the traditional scholarly 'Dozent' and 'Professor'; but the men would be chosen for their pedagogic aptitude and enthusiasm, rather than for their eminence in a particular scholarly discipline.

(4) The recommendation of the Commission that the universities and technical high schools experiment with a 'studium generale', intensively in the first two semesters, less intensively in the third and fourth semesters, arises from the conviction expressed

* Gutachten zur Hochschulreform. Pp. v+132. (Hamburg: Studienausschuss für Hochschulreform, Besenbinderhof 52, 1948.)

in the report that the universities have with the increase of specialization within the separate faculties become less centres of education and increasingly places of vocational training. The opinion tacitly advanced in the report is that the need for an adjustment of equilibrium towards a knowledge and appreciation of other mental disciplines is greatest among students of science and technology: explicitly, the report recommends that in the universities the humanistic–philosophical and sociological–historical disciplines be thrown open through very general lecture courses to students of all faculties, a task in which the 'Studienprofessoren' and 'Studiendozenten' are expected to make their special contribution; and that in the technical high schools a completely new faculty of humanistic–sociological studies be founded. It is pointed out that this latter recommendation is in line with the findings of the Darmstadt Congress in 1947 on the Education of Engineers, at which the most lively appreciation of the 'dæmonic power' of technology divorced from social awareness was widely expressed.

RONALD FRASER

CHLOROMYCETIN: ITS STRUCTURE AND SYNTHESIS

By PROF. H. RAISTRICK, F.R.S.

CHLOROMYCETIN, now also known as chloramphenicol, is an antibiotic which was first described by members of the research staff of Parke, Davis and Company, Detroit, Michigan, U.S.A.[1,2]. It is a metabolic product of a new species of *Streptomyces*, *S. venezuelæ*, n.sp., isolated from soil originating near Caracas, Venezuela, and is present in the filtrate from submerged aerated cultures of this micro-organism.

The antibiotic was isolated from the culture filtrate by solvent extraction and was finally obtained as colourless or light yellow needles or plates, m.p. 149·7–150·7°. *In vitro* tests[1,3] showed that it is active against a number of Gram-positive and, significantly, also against many Gram-negative bacteria. J. E. Smadel and E. B. Jackson[4,5] showed that chloromycetin is highly active in tests on chick embryos and mice experimentally infected with a number of rickettsiæ and viruses, including rickettsial pox and the viruses of psittacosis and lymphogranuloma venereum.

Clinical trials of chloromycetin in human patients have given most promising results. Twenty-five proved cases of scrub typhus were treated with chloromycetin at Kuala Lumpur, Malaya[6]. Twelve comparable cases served as controls. In the treated patients there was a remarkable response, there being no deaths and no complications. In the control patients, one died and two had complications.

Twenty-two cases of epidemic, louse-borne typhus were treated during an epidemic of this disease in the Department of La Paz, Bolivia, during late 1947 [7]. Fifty untreated cases of typhus, of whom fourteen died, occurring in the same epidemic, served as controls. The favourable effect of treatment with chloromycetin appeared rapidly and the patient usually entered convalescence within three days. All of them made a rapid recovery.

Until a few days ago, very little had been published on the chemistry of chloromycetin. It was known[1,2] that chloromycetin contains carbon, hydrogen, oxygen, nitrogen and non-ionic chlorine. But although analyses of the substance were published[1,2], no empirical formula was assigned to it. Then, in the issue of *The Times* of March 28, there appeared a short communication entitled "Artificial Production of Chloromycetin" from its New York correspondent. This article contained the following statement which must have made many a biochemist who read it feel considerable scepticism:

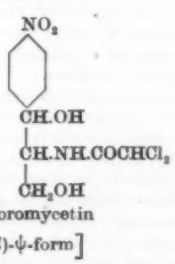
"In making the drug chemically research scientists found for the first time a natural compound containing a nitro-benzene grouping that has always been thought harmful to animal life. Now it was found to be harmless as part of the antibiotic. They found also that the drug was a derivative of dichloracetic acid, another chemical never before found in a natural product."

The second part of the statement is not particularly surprising since a number of mould metabolic products are known which contain non-ionic chlorine, and one of them, caldariomycin[8], $C_5H_6O_3Cl_2$, which is almost certainly 2 : 2-dichloro*cyclo*pentane-1 : 3-diol, contains the grouping —CCl_2—CHOH—, which is not unrelated to dichloracetic acid. The presence of a nitro-benzene grouping was so contrary to one's biochemical instincts as to appear very improbable.

All one's doubts on this point, however, were set at rest by the receipt in Britain of the abstracts of three papers on the structure and synthesis of chloromycetin by members of the research staff of Parke, Davis and Company, headed by their director, Dr. Leon A. Sweet. These papers were read at a meeting of the Division of Medicinal Chemistry of the American Chemical Society held in San Francisco, California, on Tuesday afternoon, March 29.

In the first abstract, dealing with the structure of chloromycetin, the empirical formula $C_{11}H_{12}Cl_2N_2O_5$ was assigned to it, and it was shown to form a di-*O*-acetyl compound. It was further stated that "acid or alkaline hydrolysis produces a halogen-free base and a halogen-containing acid. The base contains both nitrogen atoms, one of which is present as a primary amine and the other as an aromatic nitro group".

The other two abstracts deal with two different approaches to the synthesis of chloromycetin, but too briefly and in too vague terms to describe them profitably, and no structural formula for chloromycetin was advanced in them. It has now been announced by the Parke, Davis Research Laboratories[9] that chloromycetin has the structure shown and is described as (*l*)-ψ-1-*para*nitrophenyl-2-dichloro acetamido propane-1 : 3-diol.



Chloromycetin

[(*l*)-ψ-form]

It will be seen that this structure contains two asymmetrical carbon atoms, and the authors state that one of the isomers—that described above—"proved to be identical in all physical, chemical and

biological properties with chloromycetin produced by fermentation. The three other isomers were essentially inactive in the biological test".

Smadel *et al.*[10] have shown that "synthetic chloromycetin appears to possess the same rickettsiostatic and virustatic properties in experimental infections and the same usefulness in treating patients with scrub typhus that have been demonstrated for fermentation chloromycetin."

Dr. Sweet and his colleagues are to be sincerely congratulated on a brilliant achievement, but I feel sure that any of them who were associated with the determination of the structure of penicillin and its synthesis will agree that they have this time been more fortunate in having a simpler and more rational antibiotic to synthesize. The tables have been completely turned on the fermentation chemist who, though he can even now rightly claim that synthetic penicillin cannot compete economically with penicillin made by fermentation, is faced with the fact that it is almost certain that synthetic chloromycetin will quite quickly become, even if it has not already become, much cheaper than chloromycetin made by fermentation. It now remains to be seen whether aureomycin, an antibiotic from *Streptomyces aureofaciens* discovered by the research staff of the Lederle Laboratories, Pearl River, N.Y., will, in the words of the writer of this article[11], "prove to be competitive with, or supplementary to chloromycetin", since these two antibiotics have somewhat similar biological properties and both of them contain chlorine and nitrogen.

[1] Ehrlich, J., Bartz, Q. R., Smith, R. M., Joslyn, D. A., and Burkholder, P. R., *Science*, **106**, 417 (1947).
[2] Bartz, Q. R., *J. Biol. Chem.*, **172**, 445 (1948).
[3] Smith, R. M., Joslyn, D. A., Gruhzit, O. M., McLean, I. W., Penner, M. A., and Ehrlich, J., *J. Bact.*, **55**, 425 (1948).,
[4] Smadel, J. E., and Jackson, E. B., *Science*, **106**, 418 (1947).
[5] Smadel, J. E., and Jackson, E. B., *Proc. Soc. Exper. Biol. and Med.*, **67**, 478 (1948).
[6] Smadel, J. E., Woodward, T. E., Ley, H. L., Philip, C. B., Traub, R., Lewthwaite, R., and Savoor, S. R., *Science*, **108**, 160 (1948).
[7] Payne, E. H., Sharp, E. A., and Knaudt, J. A., *Trans. Roy. Soc. Trop. Med. and Hyg.*, **42**, 163 (1948).
[8] Clutterbuck, P. W., Mukhopadhyay, S. L., Oxford, A. E., and Raistrick, H., *Biochem. J.*, **34**, 664 (1940).
[9] *Lancet* annotation, **256**, 576 (1949).
[10] Smadel, J. E., Jackson, E. B., Ley H. L., and Lewthwaite, R., *Proc. Soc. Exp. Biol. and Med.*, **70**, 191 (1949).
[11] Raistrick, H., *Nature*, **163**, 159 (1949).

CYTOLOGY AS A FACTOR IN TAXONOMY

AT the rooms of the Linnean Society at Burlington House, on March 10, there was a joint meeting of the Linnean Society and the Systematics Association to discuss cytology in relation to botanical and zoological taxonomy.

The opening paper of the meeting was by Dr. W. B. Turrill. He considered that taxonomists have a twofold task: first, to provide the means of determination of organisms, and, secondly, to work towards an ideal classification that shall incorporate systematically all knowledge regarding organisms. Cytology, in all its branches, is contributing to both these ends, but particularly to the second. The extra-nuclear constituents of the cell must not be neglected in relation to taxonomy, but modern research has been concentrated on the nucleus and particularly on the chromosomes. The morphology of chromosomes, their structure, shape and size, and even their biochemical and biophysical constitution, provide additional data for distinguishing taxonomic groups, and such data must be given a fair but not undue valuation in taxonomic studies. The behaviour of chromosomes, especially in relation to reproduction, as correlated with the results of genetical experiments, is even more important than their appearance. Such phenomena as sterility, apomixis, and the production of polyploids have a direct bearing on species problems. The importance of an understanding of sterility barriers was illustrated by the behaviour of the British species of *Centaurea*. Hybridization is easy between members of the *C. jacea* and *C. nigra* group, and hybrid swarms are produced in the wild between species with similar chromosome sets; while it has been found impossible to cross these with *C. scabiosa*, which has a very different set. Polyploids raise many problems to the taxonomist and there is probably no satisfactory single rule for solving them. Apomicts, too, need further consideration. Dr. Turrill holds that they should not be treated as 'species' but as a distinct category. In the dandelions (*Taraxaca*) these apomicts seem almost innumerable, and how far it is worth while to attempt to distinguish them may be debated.

The use of cytology at the taxonomic level of genera and families was referred to in connexion with Ranunculaceæ and Berberidaceæ. Dr. Turrill ended with a plea for closer co-operation between taxonomists and cytologists, and expressed the hope that more cytologists or cytogeneticists would be appointed to institutions with botanic gardens.

Dr. S. Muldal dealt with breeding systems in species of earthworms. He outlined the characters used in classification and the geographical distribution of genera of the Lumbricidæ found in Britain. Three modes of reproduction can be distinguished: (1) sexual, where no cocoons can be produced without copulation; (2) facultative parthenogenesis, where copulation is the rule, but cocoons can be produced in isolation; (3) obligatory parthenogenesis, where fertile cocoons are produced by isolated individuals and where copulation as a rule does not take place. The first type is found in all British species of *Allolobophora*. The second mode of reproduction is found in *Eisenia*, *Lumbricus*, and species of *Dendrobæna*. Obligatory parthenogenesis occurs in *Octolasium*, *Eiseniella* and *Bimastus*. Different basic chromosome numbers occur in several of the genera (for example, *Eisenia* and *Allolobophora*), and a somewhat complicated scheme was presented showing the possible relationships and origins of the genera, some of which, on the evidence of their cytology, appeared to be polyphyletic.

Col. F. C. Stern considered, by reference to several genera of flowering plants, how chromosome numbers and shapes help in distinguishing species closely similar in morphological characters, and further, how cytological facts help in elucidating phylogeny. Genera or sections of genera may have in all their constituent species the same basic number, while in other genera several such numbers are known. Col. Stern dealt with problems relating cytology to taxonomy and distribution in *Pæonia*, *Primula*, *Leucojum* and *Galanthus*. His remarks were illustrated by specially prepared lantern slides of coloured maps and by specimens loaned from Kew.

In the genus *Pæonia*, all the European species are either diploids or tetraploids. It is possible to sort the species into groups on morphological characters, and in many such groups there is then found to be

one species diploid and one tetraploid. Generally, the diploids have restricted distributional areas, as in an island or island group in the Mediterranean, while the tetraploids have much wider ranges. In *Primula*, section Eufarinosæ, the species are very closely related in morphological characters, but the series shows polyploidy with close correlation between chromosome numbers and geographical ranges in Eurasia and North and South America. *Primula stricta*, extending right across the Arctic regions in Europe and North America, is a 22-ploid species. In *Leucojum*, basic chromosome numbers of 7, 8, 9 and 11 are found, whereas in *Galanthus* the basic number is 12. *Galanthus elwesii* is a tetraploid, and one triploid has been recorded in wild material. It has been shown that in the genus *Fritillaria* increase of chromosome number has probably occurred by splitting at centromeres. It is suggested that derivation of species in the *Leucojum-Galanthus* series has been associated with a comparable increase in chromosome number from an ancestral form with a basic number of 7, a number still present in *Leucojum autumnale*. The species of *Leucojum* are especially abundant in the countries of the western Mediterranean basin and those of *Galanthus* in the eastern Mediterranean basin. Col. Stern put forward as a possibility the hypothesis that a common ancestral type was driven south by the spread of ice and cold temperatures during the Ice Age and, diverging west and east, became differentiated into what are now accepted as the two distinct but closely related genera *Leucojum* and *Galanthus*.

An interesting and valuable discussion followed the three principal papers. Speakers mostly agreed that cytology has valuable contributions to make to taxonomy; but there was some difference of opinion as to the desirability of changing the taxonomic status of a group solely or mainly on cytological or cytogenetical evidence. Several speakers expressed their definite opinion that, on the whole, taxonomists have 'done a good job of work', since most often later cytological findings have been in close or even exact agreement with previously devised classifications. Dr. S. C. Harland, for example, said that the combination of modern cytological and genetical techniques applied to the genus *Gossypium* has enabled improvements to be made in classification, but the results have left the modern systematics very near to the older classification. One genus has been re-incorporated in *Gossypium*, and two species have been expelled. Dr. Harland also emphasized the use of grafting in tracing affinities. Prof. T. G. B. Osborn pointed out that in the genus *Eucalyptus*, which is very rich in species in Australia, there is one basic chromosome number, whereas in the Epacrideæ there is an incredible range of chromosome numbers.

Prof. A. D. Peacock referred to the group of sawflies and compared their chromosome numbers with those found in earthworms. He asked if, in both earthworms and plants, there were any relationships between polyploidy and habits and habitats. Dr. O. W. Richards asked if, in view of the cytological findings, it would not be advisable to abolish all the genera of Lumbricidæ and start again by making genera based on the chromosomes. Dr. J. Ramsbottom said he agreed with Dr. Turrill that chromosome number, size and shape give micro-morphological characters that must not be over-valued taxonomically. In the Fungi, the nuclei are so small that little of taxonomic importance has been done on the cytology of the group. Polyploidy has no significance in the present state of mycology, and as yet many cytological problems, such as that of brachymeiosis, are undecided.

Dr. D. H. Valentine directed attention to changes in chromosome number in the genus *Crepis* as recorded by Prof. Babcock. Changes in the haploid number from $n = 4$ to $n = 3$ by reciprocal translocations have been demonstrated. Many autopolyploids (autoploids) have now been recognized in different genera, and many of these are difficult to distinguish from the corresponding diploid. In *Rumex acetosella*, diploid, tetraploid and octoploid types have been separated as different species, because they will not cross together and are distinct in geographical distribution. Prof. Skalinska found tetraploids and octoploids of *Valeriana officinalis* in Britain, and these are indistinguishable by gross morphological characters over most of their areas of distribution. They will not cross, however, and there are differences in size of pollen grain and stomatal index. Dr. Valentine would call these different species and not chromosomal races, because of their genetical isolation and physiological differences. Dr. E. F. Warburg criticized any suggestion of a sharp distinction between morphological and physiological characters in chromosomes, since the former show a reflexion of the latter. Chromosome number itself may indicate sterility. He also disagreed with Dr. Valentine on the desirability of recognizing chromosomal races in *Valeriana* as distinct species. Mr. A. J. Wilmott said that since there are different kinds of plants and since 'species' means 'kind', one must expect species to be different one from another in degree of distinctness. If plants are to be accepted as belonging to different species, they must have different characters and different distribution in time. He raised the question as to how long it takes species to develop. It has been suggested that there are a limited, not an unlimited, number of *Taraxacum* apomicts.

Dr. C. R. Metcalfe stressed the value of anatomy in plant classification, since it gives a greater number of characters with which to work, especially in larger groups where it is difficult to obtain sufficient cytological data. Tetraploids and octoploids in *Valeriana* show differences in anatomy parallel to the cytological differences. A corresponding parallelism is also found in the Oleaceæ.

In reply to questions raised, Dr. Turrill pointed out that it is difficult to generalize on the relationships between polyploids and habitats. Some facts seem to indicate that polyploids, as a rule, are able to withstand more extreme habitat conditions than the corresponding diploids, but there are so many exceptions that further research is essential before satisfactory conclusions can be reached. With regard to distinguishing morphological from physiological characters in the study of chromosomes, it was not intended to suggest that this was more than a matter of convenience in summarizing facts; but it is sometimes risky to assume that exact differences of behaviour can be foretold from structural characters in the absence of direct experiments. With regard to *Taraxacum* apomicts, the actions of those who state that these apomicts are limited in number belie their words, for they continue to describe new ones (usually as 'species') apparently indefinitely.

The chairman, Prof. W. H. Pearsall, thanked those who gave the papers and those who had contributed to the discussion; he said he was left with the impression that there was more than one basis for distinguishing differences between species.

OBITUARIES

Mr. P. Bruce White, F.R.S.

THE scientific achievement of Philip Bruce White, who died on March 19 at the age of fifty-seven, was a remarkable example of a contribution to medical bacteriology by a non-medical man. Bruce White came of a Scottish family whose connexions included the late Prof. J. C. Philip and Sir Robert Philip, the well-known professor of tuberculosis in Edinburgh. He himself was born and brought up in Bangor, where his father, P. J. White, was the first lecturer in zoology and later for many years professor of this subject in the University College of North Wales. It was from his father that Bruce White acquired his enduring interest in biology, although the intellectual approaches of the two men to the subject had little in common; the father was a natural historian with the interests and the habits of mind of the collector, whereas the son was above all a versatile and ingenious experimenter.

Bruce White was educated at Friar's School, Bangor, and later at the University College of North Wales, where he graduated in science in 1915, his chief subjects being botany and zoology; his first essay in bacteriology was an undergraduate research on black rot in mangolds. His original intention had been to study medicine after graduation in science, but the desire to take a more active part in the First World War caused him to abandon this plan, although he did go so far as to take an extra-mural course in human anatomy at Edinburgh. With the object of improving his knowledge of bacteriology he went to the Lister Institute, where he came under the influence of the late Sir Joseph Arkwright. After a few months he accepted a post as assistant pathologist at Trinity College, Dublin, an appointment which plunged him into work far outside his experience and eventually involved him in the excitement of the Easter Rebellion of 1916.

Bruce White finally found direct war-time employment when he was appointed civilian pathologist at Tidworth Military Hospital, where he worked until 1919. On his release from this duty he joined a team working on bee disease at Aberdeen, and here he found the opportunity for his first important scientific contribution. It was due to his shrewd observation that a mite infestation was identified as the cause of Isle of Wight disease in bees.

Having left Aberdeen, and after an interval of teaching at Bangor and work for the Fisheries Board, Bruce White in 1921 joined in studies of food poisoning organised by the Medical Research Council and the Ministry of Health; this appointment marked the beginning of his serious career as a bacteriologist and of the work for which he will be chiefly remembered, namely, his studies of the *Salmonella* group. The research extended over many years; it was conducted first under Dr. W. G. Savage at Bristol and later at the Lister Institute and at the National Institute for Medical Research, which he joined as a member of the scientific staff of the Medical Research Council in 1927; it led to the classification of a most important group of organisms and provided the basis for diagnostic methods now universally employed. In more recent years Bruce White worked principally on cholera; here again his interest was mainly in the precise characterization of the pathogenic strains of cholera vibrios and in their relationships to harmless related organisms. The reputation which he had established as an authority on the bacteriology of cholera caused him to be invited to India in 1946 to take part in and advise on cholera research in that country, and in 1947 to be sent to investigate the epidemic of cholera in Cairo.

Bruce White was something of an original in medical research. He was essentially an individual investigator, unsystematic in his methods and having a curious nocturnal habit of work as unconventional as had been his training. His zeal for experimentation far outran his inclination to keep records. With all this he achieved much, and his main contributions will live in the history of bacteriology. Outside his work he had a keen interest in art and a deep knowledge and appreciation of French literature. He was a man with a keen sense of humour and a great kindliness of nature. Above all, he had the lovable characteristic of a catholic gift for friendship, and for this he will be held in affectionate remembrance by all who knew him. The sympathy of his many friends will be with his widow and two sons in their bereavement.

C. R. HARINGTON

Capt. G. C. Shortridge

CAPT. GUY C. SHORTRIDGE, director of the Kaffrarian Museum, King William's Town, South Africa, died suddenly while working alone in the Museum on January 12. He was born on June 21, 1880, at Honiton, Devon, where his father was in medical practice. From his earliest youth, Shortridge was interested in natural history, and after serving in the South African Constabulary during the Boer War, he was engaged by the late Mr. W. L. Sclater, then director of the South African Museum, to collect mammals and birds in Pondoland and the Colesberg district. After he had returned to England, he made the acquaintance of Oldfield Thomas, who arranged for him to collect mammals and birds in south-west Australia. Then he went to west Java and brought back a great collection of 1,500 mammals. In 1908 he went to Guatemala to obtain live animals for the Zoological Society, and on his return joined the British Ornithologists' Union jubilee expedition to New Guinea. In 1911 the Bombay Natural History Society inaugurated a mammal survey, and Shortridge was engaged to collect for the Society. He did good work in southern India and then was sent to Burma. Previously little systematic collecting had been done there, and our present knowledge of the mammals of that country is due to his excellent work.

He saw service in the First World War in France, Palestine and Iraq, where he was attached to the Royal Air Force as an observer. After the signing of the armistice he was appointed second-in-command of the R.A.F. Cape-to-Cairo aerodrome survey, and, on completion, went to collect mammals in Northern Rhodesia for the British Museum. While on that expedition he was appointed director of the Kaffrarian Museum, and took charge in 1921. Thereafter, scarcely a year passed without Shortridge making an expedition to some part of the Union. He first confined his attention to South-west Africa, financed partly by the Percy Sladen Memorial Fund, and the results of the expedition were described by Thomas and Hinton. In 1930–33 he published "The Mammals of South-west Africa".

At the outbreak of the Second World War he volunteered for service; but his age prohibited him from seeing active service, though he did good work in charge of a base camp in Abyssinia. Previous to that he compiled a very useful little gazetteer of Abyssinia for the use of the troops. After the defeat of the Italians, Shortridge returned to the Museum, and as soon as the War was over started making expeditions again. In 1946, accompanied by Mr. A. S. Vernay, of New York, who financed the expedition, Shortridge extended his investigations to Nyasaland. Only last year, when sixty-eight, he made a very successful collecting trip to the Albany district.

During his twenty-eight years service in the Kaffrarian Museum, Shortridge undertook thirteen collecting expeditions in search of mammals, with the result that the Museum now contains some 25,000 specimens—a unique collection of South African mammalian fauna. Although Shortridge's chief interest was in mammals, he did not neglect other groups, and, as a result of his extensive collecting, the Museum collections have quite outgrown the original building. Recently plans were prepared for building an extension.

Shortridge was a great collector, and wherever he went he always made friends and interested people in his work. He was the leading authority on South African mammals, and though he did not write many papers, he had a very wide knowledge which was always available to his correspondents. Expeditions cannot be run without funds, and Shortridge had a wonderful way of raising money and co-operating with other museums.

Prof. Douglas Hay

In these days, when the appeal is for men of experience to run the world's industries, the sudden silencing of an authentic voice is a matter for sorrow deeper than the grief so often hidden beneath the vesture of public or official mourning. The death, on February 24 at the age of sixty, of Prof. Douglas Hay, one of the two chief mining engineers of the National Coal Board and a past-president of the Institution of Mining Engineers, has left a gap in the industry that will be hard to fill. For he had travelled the trying road of experience and passed the milestones of change in mining until he reached the highest position in his profession. Those who knew that quiet, unassuming charm which was so big a feature of his life understood fully that it was an advancement due not only to his great technical and administrative ability, but also to a sympathetic personality that enabled him to get on well with those with whom he came into contact. He won the affection of miners through sympathetic personality, an unending thought for others, and a friendship that had no bounds.

Douglas Hay went to King Edward VI Grammar School, East Redford, and later to University College, Nottingham, with mining in his blood. His father was Mr. W. Hay, a mining engineer, of Sheffield. There were no favours for young Hay. He worked underground at Tinsley Park Colliery, was later apprenticed at Shirebrook Colliery, Notts, and in 1910 he obtained his first-class colliery manager's certificate; two years later, he received the James Forrest Medal and Miller Prize of the Institution of Civil Engineers. He delivered the first Cadman Memorial Lecture of the Royal Society of Arts in 1947, and the William Menelaus Lecture in the same year to the South Wales Institute of Engineers. He was honorary professor of mining in the University of Sheffield.

Prof. Hay had been H.M. Inspector of Mines in Durham and later in North Staffs. He was general manager of Newton Chambers and Co.'s collieries, Chapeltown; managing director of Barrow Barnsley Main Collieries, Ltd., and of the Barnsley District Coking Co., Ltd.; and technical director of Wombwell Main Colliery Co., Ltd. He was a member of the Holland Committee on Qualifications of Colliery Officials; consulting engineer, in conjunction with the late Dr. J. S. Haldane, on ventilation problems of the Mersey Tunnel; and later adviser on ventilation for the Dartford–Purfleet Tunnel under the Thames, and important war-time underground factories.

The Midland Institution of Mining Engineers elected him president in 1923, and he remained in that position until 1936. In 1928 he became a member of the Council of the Institute of Mining Engineers. Mining gave him its greatest honour when, in 1945, the Institute of Mining Engineers elected him as its president, and the work which he did in the three years of his office will always remain his memorial.

Prof. Hay's outstanding contribution, which will have far-reaching influence, perhaps for generations, was his work, often against strong opposition, in connexion with the raising of the standard and professional status of mining engineers, culminating in the associate membership examinations of the Institute of Mining Engineers announced in 1946, the introduction of groups, and the raising of the qualifications required for admission, pending the introduction in 1952 on a compulsory basis of the associate membership examinations.

Mr. John Ardagh

JOHN ARDAGH was born at Fulham on June 15, 1885, and died at Maidstone on March 8 last. At an early age he was taken to Ireland by his parents, and, when fourteen, became a boy attendant at the Dublin Museum. In 1919 he was transferred to the British Museum (Natural History) and worked in the herbarium. After three years he was appointed clerk-in-charge of the Botanical Library. He soon proved his capabilities as a librarian and gradually built up a considerable reputation among his colleagues and with visitors. The richness of the Library in manuscripts and drawings, as well as in old books, provided him with abundant scope for the exercise of his special qualities. He was ever ready to give freely of his knowledge or to search for facts of interest to others. He contributed several bibliographical notes to the *Journal of Botany*, and, with H. W. Renkema, gave an account of the various editions of A. B. Lambert's "Pinus", in the *Journal of the Linnean Society*. He was elected an associate of the Linnean Society in 1939. In addition to his keenness on everything connected with the 'circles' of Sloane and Banks, he made a hobby of the history of old London, and often contributed to *Notes and Queries*.

Ardagh was of quiet and somewhat stolid demeanour, slow moving but mentally alert, and warm-hearted. He retired from the Museum in September 1947 on account of ill-health, and was never well enough to visit it again. J. RAMSBOTTOM

NEWS and VIEWS

Organic Chemistry at the Imperial College: Sir Ian Heilbron, F.R.S.

THE departure of Sir Ian Heilbron from the chair of organic chemistry at the Imperial College of Science and Technology will be a great loss to the Royal College of Science and to the University of London. For the past thirty years at the Universities of Liverpool (1920–33), Manchester (1933–38) and London (1938–49), Sir Ian has led and inspired large schools of research in many different branches of organic chemistry. One of the most distinguished organic chemists of this period, he has made numerous outstanding contributions to his subject which have deservedly brought to him both national and international fame and honours. There are few fields in organic chemistry which he has not entered, but particular mention must be made of his important work on the chemistry of the sterols, vitamins, triterpenes, penicillin, heterocyclic and acetylenic compounds.

Sir Ian believes in the closest collaboration between academic and industrial workers. He himself has kept pace with developments in both spheres, and by his vision and foresight he has seen more clearly than most of his contemporaries the shape of things to come, the goals to be reached and the prizes to be won. Always eager to try new devices, new reagents and new reactions, he has made the greatest possible use of physical methods both for the isolation of pure materials and for the elucidation of their structures. He was one of the first to use chromatography in Great Britain. His influence on the development of organic chemistry during the past thirty years has been profound and far-reaching, and his brilliant lectures have done much to stimulate interest in this branch of chemistry. Sir Ian Heilbron is, above all, an organic chemist in the true classical tradition, and by his work, his example and his outlook he has shown in unmistakable terms his firm belief that in the further elucidation of the chemistry of natural products and processes organic chemistry has a great future.

Prof. R. P. Linstead, C.B.E., F.R.S.

DR. R. P. LINSTEAD has accepted an invitation to succeed Sir Ian Heilbron as professor of organic chemistry and director of the organic chemistry laboratories at the Imperial College of Science and Technology. He thus returns to the College where he received his early training and where he was for many years a member of the staff. His earlier work has already been referred to in a previous notice (see *Nature*, **156**, 415; 1945), although one might mention, in addition, some interesting work on liquid-phase reactions under very high pressures done in collaboration with Prof. D. M. Newitt, and on the chemistry and pharmacology of the heart poisons with Prof. O. Krayer. As director of the Chemical Research Laboratory, Teddington, Prof. Linstead has occupied a key position in the linking together of Government, academic and industrial chemical research. The time of his appointment (1945) coincided with the transition period from war- to peace-time conditions, with consequent re-orientation of work and planning for the future. To this task he brought a wide scientific knowledge combined with administrative ability. Under his vigorous leadership objective fundamental research at the Laboratory received fresh impetus and direction. In his new post Prof. Linstead becomes the successor of a series of distinguished men who have built up a school of organic chemistry second to none in Great Britain, and one may confidently predict that under his ægis it will continue to flourish.

National Research Council of Canada: Dr. R. W. Boyle

DR. ROBERT WILLIAM BOYLE, who, since 1929, has been director of the Division of Physics, National Research Council of Canada, retired last year. Born in Carbonear, Newfoundland, he received his early education at St. John's College and then proceeded to McGill University, where he graduated in electrical engineering in 1905, obtaining his master's degree in 1906, and doctorate in 1909. As an 1851 Exhibition scholar he studied radioactivity under Rutherford at Manchester during 1909–11, and then returned to McGill as lecturer. From 1912 to 1929 he was professor and dean of applied science in the University of Alberta. During 1916–19 he had a brilliant record of service, first with the Admiralty Board of Inventions and Research and later with the Anti-submarine Division. Here he was in charge of the scientific research and development of what later became known as the 'Asdic' for submarine detection. It is in this sphere of ultra-sonics that Dr. Boyle has specialized, and he and his co-workers have produced a wealth of data on ultra-sonic propagation, energy distribution in beams, reflexion, transmission, interference and detection. Dr. Boyle organised the Division of Physics and Engineering of the National Research Council in 1929, and the steady growth and expansion of this Division owes much to his directorship. In 1937 it became the Division of Physics and Electrical Engineering; and during the Second World War the radio and electrical engineering branches expanded so greatly that they were split off in 1948 as a separate Division, and the parent was renamed the Division of Physics. Dr. Boyle has been succeeded by Dr. G. Herzberg (see *Nature*, February 12, p. 241).

Medical Physics at the University of Pennsylvania: Dr. Britton Chance

DR. BRITTON CHANCE has been appointed director of the Eldridge Reeves Johnson Foundation of Medical Physics in the University of Pennsylvania in succession to Dr. Detlev W. Bronk. Dr. Chance, who was previously associate professor of biophysics in the University of Pennsylvania, graduated from that University in 1935 and became interested in the kinetics of enzyme action. In 1938 he started work at Cambridge on an electronic device of his own invention for steering ships, and later undertook research in the United States on electronic circuits in radar. At the end of the War, Dr. Chance was able to return to his enzyme studies in the laboratories of Prof. H. Theorell in Stockholm and Prof. D. Keilin in Cambridge. His work on the enzymes peroxidase and catalase constitutes an entirely new approach to the study of the very short-lived intermediate compounds which these enzymes form with peroxides. The formation of such compounds is characterized by changes in absorption spectra; but the reactions are too rapid to be recorded at concentrations sufficiently high for normal methods of spectroscopic observation. Dr. Chance's extensive knowledge and experience of radio technique enabled him to develop the Roughton and Millikan method for the study of rapid reactions to a stage where optical density changes of the order

of 0·001 could, through high amplification of a photocell current, be instantaneously and accurately recorded. At the high dilutions which can in consequence be employed, the enzyme-substrate reactions proceed at rates which permit detailed analyses. The value and scope of this experimental technique in the field of reaction kinetics can scarcely be overestimated.

Mechanical Engineering in Queensland: Prof. Mansergh Shaw

THE appointment of Mr. Mansergh Shaw to the new chair of mechanical engineering in the University of Queensland, Brisbane, Australia, marks another important step in an unusually successful engineering career. It is interesting to note that, after serving a normal engineering apprenticeship with Messrs. Davy Brothers, Prof. Shaw became an undergraduate at the University of Sheffield through the award of a Whitworth scholarship; he graduated in 1935 with first-class honours and was awarded the Mappin Medal. Thereafter he became a lecturer at the University of Sheffield and conducted research work on fluid flow through nozzles and on other subjects. He was appointed senior lecturer in engineering at the University of Melbourne in 1938, a position which he occupied with conspicuous success for some ten years under Prof. A. E. Burstall. During the War, in addition to undertaking special defence training duties, Shaw was responsible for organising the University workshops at Melbourne for research on new methods of production and on the precision manufacture of optical and other instruments required by the Australian Defence Forces. At the same time he was engaged upon new investigations of transient cutting forces and of factors affecting surface finish. This research is reflected in a number of published works on engineering production methods. On his return to England last year on extended leave, he was appointed as the first Tube Investments Research Fellow in engineering production in the University of Birmingham. Prof. Shaw has an important task awaiting his arrival at Brisbane, where he will have to build up a new Department of Mechanical Engineering. His wide experience of engineering practice, teaching and research, and his great energy and enthusiasm, augur well for the future progress of engineering education in Queensland.

Kodak Research Laboratories

ON March 25 and 26 a conversazione was held at the Research Laboratories of Kodak, Ltd., Harrow, to mark the twenty-first anniversary of their opening. The Laboratories were visited on March 25 by representatives of all fields of scientific interest, and on the following day by members of the six thousand factory and sales staff. The exhibits displayed the range of scientific endeavour of the Laboratories. A historical exhibit provided a reminder that the photographic industry has always been closely associated with scientific research, particularly since 1912 when Dr. C. E. K. Mees, now vice-president of the Eastman Kodak Company, left the old-established firm of Wratten and Wainwright to found and direct the research laboratories of the Eastman Kodak Company. The English branch of the organisation became an independent centre for research in 1928, when Dr. W. Clark set up the first Kodak, Ltd., Research Laboratory. Since 1931, Mr. E. R. Davies has been director of research.

In the fields of photographic physics and emulsion making, attention was directed to the application of photographic emulsions to the study of atomic phenomena. Photographs and drawings of tracks in emulsions were shown, which gave ample support to the claim that the photographic emulsion can now rival the cloud chamber as a nuclear research instrument. In another section a new instrument for the study of colour vision was shown. This has been designed particularly for the examination of adaptation phenomena, of paramount importance in the subjective aspects of colour photography. Examples of work in organic chemistry were to be seen in two sections. Sensitizing dyes continue to demand a considerable effort, while the chemistry of colour photography presents new problems. Some new and original apparatus was seen in the physical chemistry section, including a sensitive swell-recording device for studies of the physical properties of gelatin. In optics, war-time work on the resolving power of the lens-film system is being extended to cover the range of focal lengths in use in amateur and professional photography. The electron microscope has been added to the list of resources available for studying the fundamental problem of the latent image, and many properties of the individual silver halide grain have been shown for the first time. The applications of photography to science and industry were fully displayed. Some of the most interesting examples were those dealing with animal studies, such as the tongue action of reptiles, for which a high-speed stroboscopic light source has been designed.

Ray Society: Annual General Meeting

THE hundred and fifth annual general meeting of the Ray Society was held on March 18. The volume of Pennant's "Tour on the Continent 1865", edited by Prof. G. R. de Beer, was published and distributed during the past year, and it was announced that Prof. N. J. Berrill's volume on "Tunicates" had gone to press; that the manuscript of the first volume of Messrs. Locket and Millidge's work on "British Spiders" had been received and had gone to tender, and that the manuscripts of the second volume of Prof. Balfour-Browne's "British Water-Beetles", of the late Prof. Tattersall's "British Mysidacea" and of Messrs. Dandy and Milne-Redhead's "Watsonian Vice-counties" were expected in the near future; and it was hoped that one or more of these volumes would also be published during 1949. It was pointed out that this programme of publication would put a serious strain on the Society's finances, and it was urged that every effort should be made to increase the membership and to enlist other means of support. Prof. G. R. de Beer, Mr. A. C. Townsend and Dr. Errol White were re-elected president, honorary treasurer and honorary secretary respectively; Dr. Edward Hindle and Dr. John Smart were elected vice-presidents, and Dr. W. J. Rees, Mr. Herlihy, Mr. M. A. C. Hinton and Prof. F. E. Weiss new members of council.

Nature of Plastics

A NEW 16-mm. sound and colour film, "The Nature of Plastics", which has been sponsored by Bakelite, Ltd., was shown for the first time at the British Council Theatre in London on April 5. The film, which runs for about 20 minutes, is a scientific documentary and is designed to explain to the intelligent layman the broad principles of the structural characteristics of plastics and their

associated physical properties. The molecular chain structure is particularly emphasized and is illustrated by large-scale molecular models: Then, with the aid of mechanical analogies, the packing of the chains is related to the physical properties, tight-, medium- and loose-packing corresponding to fibres, heat-softening plastics and rubbers respectively. In the case of the rubber structures, the chains can be locked by means of cross-connecting atoms, and this produces a heat- and chemical-resistant material which is called a heat-hardening or thermosetting plastic. The use of fillers to improve this plastic is also discussed. To illustrate the chemistry, the phenol-formaldehyde plastic is considered. The last part of the film ranges over the industrial use of plastics. The production of the film is of a high standard, and scientific accuracy has been maintained throughout. No doubt the film will be widely used for educational purposes, and it can be strongly recommended for showing to senior forms of schools, etc. Applications for the loan of prints should be made to Bakelite, Ltd., 18 Grosvenor Gardens, London, S.W.1.

Plant Propagation by Cuttings

A USEFUL short paper by E. E. Kemp (*J. Roy. Hort. Soc.*, **73**, Part 9, 291–305; Sept. 1948) gives some very practical information on the rooting of more 'difficult' cuttings. The author draws on the extensive practical experience of the Edinburgh Royal Botanic Garden to describe the important factor of selection of material for this type of propagation. Descriptions of this are greatly helped by a series of very clear photographs. In the sections on preparation of cuttings for insertion and on rooting media, the writer interprets practically the physiological approach typified by Priestley and Swingle. Nodal cuttings are more generally satisfactory because of the absence of pith and the presence of additional meristem. The effect of environment on the healing of the cut wound and subsequent formation of callus and roots are also described on a physiological basis, which further indicates the chief desiderata of the rooting medium—air and water. It is indeed refreshing, in this era of hormonal rooting of cuttings, to find a good exposition of the blending of 'normal' physiology with practice for dealing with some of the difficulties of propagation.

Industrial Management

A BOOKLET by Colonel L. Urwick entitled, "Occasional Papers No. 1: A Short Survey of Industrial Management", is the first of a series published by the British Institute of Management; it consists of 32 pages and is priced at 2*s.* 6*d.* After reviewing successively the nature of management, the evolution of 'scientific management', and the mechanics and dynamics of management, Colonel Urwick emphasizes the immense amount of work still to be done, alike in widening and deepening the field of research and in securing a uniform application of the results already attained. This admirably written paper displays to the full the wide range of the author's thought and reading and his keen appreciation of the work of F. W. Taylor, Mary P. Follett and Elton Mayo. Merely as an introduction to the literature of management it could scarcely be bettered, and the bibliographical references are full and properly placed; but beyond this, Colonel Urwick writes much that is pertinent on such matters as the control of production, the selection of personnel, joint consultation, job analysis and the like. This paper sets a high standard which succeeding papers will do well if they can maintain.

Engineering Metrology

A FULL-TIME postgraduate course in engineering metrology (technical measurement), extending over one academic year, is being started this year as a permanent feature in the courses provided at the Manchester Municipal College of Technology. The course will deal with the science and practice of measurement in relation to engineering products and the machine tools employed in production, and to industrial and scientific research. In addition to the subject of metrology, other aspects of engineering will be dealt with in the course, and facilities for research will be provided. This course, which is the first of its kind in Great Britain, represents an initial step towards solving the problems whereby the accumulated store of engineering knowledge can be passed on to the newcomers in the engineering industries and professions. Candidates for admission to the course must be of postgraduate standing. In the first year the number of admissions will be limited to a maximum of about twelve. Further information may be obtained from the Principal, College of Technology, Manchester, 1.

Biology of Water Supply

THE exhibit at the British Museum (Natural History) showing how living organisms affect our water supplies has recently been extended and re-arranged. To help the public to a better understanding of the display the original pamphlet called the "Biology of Water Supply" has been re-written by Dr. Anna Hastings and may be obtained from the Museum. Besides descriptions of the plants and animals which may enter waterworks, the pamphlet also contains an account of the treatment of river waters, the standard tests for purity, how water is delivered to the consumer and how cast-iron mains are corroded, as well as a classified list of all the plants and animals which affect water supply in some way. The pamphlet would be of considerable help to sixth-form biology teachers making use of project methods.

Research Boards of the Department of Scientific and Industrial Research

THE following new members of the Research Boards of the Department of Scientific and Industrial Research have been announced. *Building Research Board:* C. W. D. Rowe, managing director, London Brick Co. (a former member of the Board); B. Sandercock, member of executive council, Amalgamated Society of Woodworkers; R. M. Wynne Edwards, Messrs. Richard Costain, Ltd. (formerly director of constructional plant, Ministry of Works). *Chemistry Research Board:* Prof. M. G. Evans, professor of physical chemistry, University of Manchester; Dr. H. W. T. Thompson, lecturer in chemistry, University of Oxford; Dr. F. Roffey, Distillers Co., Ltd. *Forest Products Research Board:* Col. A. H. Lloyd, Imperial Forestry Institute, Oxford; H. J. Nuttall, director, Thomas White and Son, Ltd.; V. A. M. Robertson, chief civil engineer, Southern Region, British Railways. *Fuel Research Board:* Dr. R. Holroyd, research manager, Billingham Division, Imperial Chemical Industries, Ltd.; Sir Charles Ellis, scientific member of the National

Coal Board; Sir Cyril Hinshelwood, professor of chemistry, University of Oxford. *Mechanical Engineering Research Board:* Dr. C. Dannatt, chief electrical engineer and director, Metropolitan-Vickers Electrical Co.; *Pest Infestation Research Board:* Dr. C. B. Williams, chief entomologist, Rothamsted Experimental Station.

New Trends in Biology Teaching

"New Trends in Biology Teaching" is the theme of a Conference which is being held during May 6–7 at the Borough Polytechnic, London, S.E.1. This Conference is sponsored by the Association of Assistant Mistresses, the Association of Women Science Teachers, the British Social Hygiene Council, the Joint Committee of the Four Secondary Associations, the Ling Physical Education Association, the National Union of Teachers, the Royal College of Midwives, the Royal College of Nursing, the Science Masters' Association and the School Nature Study Union. Prof. S. Mangham, of University College, Southampton, will give an opening address on "Biology for Tomorrow". He will be followed by Miss Hilda Franks on "Syllabuses". Dr. L. M. J. Kramer is giving a lecture demonstration, "Preparing and Presenting Inexpensively a Year's Course Based on the Theme, 'The Child's Microbial Heritage' ". At the final session Mr. Richard Palmer will talk on "Some Neglected Aspects of Human Biology in Schools". Tickets for the Conference can be obtained from the British Social Hygiene Council, Tavistock House North, London, W.C.1, price 5*s*.

South-Eastern Union of Scientific Societies

The fifty-third annual congress of the South-Eastern Union of Scientific Societies will be held at King's School, Canterbury, during April 19–23. The new president of the Union, Mr. F. H. Edwards, of the Geological Survey, will give an address on "Geological Surveys and their Influence". A full programme of lectures, visits and excursions has been arranged, and approximately one day has been allotted to each of the three sections of archæology, geology and zoology. These sections will meet on April 20, 21 and 22 under their presidents, Mr. S. S. Frere, Mr. A. Wrigley and Major Maxwell Knight, respectively. A special feature of the congress is the 'Young Naturalists' Evening' on April 22, when a team of experts will answer questions from young naturalists. The honorary general secretary of the Union is Mr. H. Lambert, of 68 Grosvenor Avenue, Carshalton, Surrey, and the honorary local secretary for Canterbury is Mr. David Stainer, of Salisbury House, St. Thomas's Hill, Canterbury.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have been announced: P. S. Castle, agricultural officer, Gold Coast; D. Jardine, geologist, Nigeria, seconded to the Falkland Islands; I. H. Gordon, pathologist, Nigeria; G. F. P. Doran, veterinary officer, Tanganyika; C. Douglas, veterinary officer, Gambia; Miss B. A. Bennett, meteorological assistant, Bermuda; F. H. Bridge, development officer, Veterinary Department, Nigeria; J. E. McK. Horne, assistant conservator of forests, Nigeria; W. MacDonald, agricultural officer, Nyasaland; H. A. Osmaston, assistant conservator of forests, Uganda; W. J. A. Payne, animal husbandry officer, Fiji; G. Williamson, temporary veterinary education officer, Nigeria; J. V. Lewis (administrative officer, Tanganyika), deputy director of agriculture (marketing), Nyasaland; T. Bell (senior agricultural officer, Palestine), senior agricultural officer, Kenya; A. Jeffries (chief fruit inspector, Department of Agriculture and Fisheries, Palestine), agricultural officer, Tanganyika; L. A. de S. Powell (assistant headmaster, School of Agriculture, Jamaica), agricultural officer (Grade 1), Jamaica; C. S. Cree (assistant conservator of forests, Uganda), senior assistant conservator of forests, Northern Rhodesia; J. Evans (assistant conservator of forests, Palestine), assistant conservator of forests, Nigeria; K. V. W. Nicholls (meteorological officer, Federation of Malaya), meteorologist, East African High Commission.

Announcements

The Ministry of Agriculture and Fisheries announces the following appointments: Mr. W. Morley Davies, provincial director for the East Midland Province of the National Agricultural Advisory Service, to be senior education and advisory officer to succeed Dr. W. K. Slater, who, as already announced, has been appointed secretary to the Agricultural Research Council in succession to the late Sir John Fryer; Mr. Arthur Jones, director in Wales, National Agricultural Advisory Service, to be provincial director for the East Midland Province; and Mr. D. Walters-Davies, deputy provincial director, to be director in Wales.

The Chemical Society invites applications for grants for research in all branches of chemistry. Application forms should be submitted not later than May 10. Full particulars can be obtained from the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1.

A meeting of the council of directors of the International Union against Cancer will take place in Paris during July 18–22. Also participating will be government delegates of the Union, delegates of non-government organisations which are members of the Union, and members of the International Cancer Research Commission, which is integrated in the Union. Further information can be obtained from the Union Internationale contre le Cancer, 6 Avenue Marceau, Paris, 8e.

On the occasion of the Conference of the International Union of Chemistry during September 6–20, a colloquium on macromolecules will be held at Amsterdam during September 2–5. The main subject will be polymerization kinetics, and macromolecules in solution will also be discussed. Full details may be obtained from the organising committee at P.O. box 71, Leyden, Netherlands.

The Manchester Municipal College of Technology of the University of Manchester offers to part-time students six scholarships and six exhibitions varying in value up to a maximum of £140 plus approved fees, tenable for three years in any one of the full-time day courses of the College. Forms of application may be obtained from the Registrar of the College of Technology, Manchester, 1, and must be completed before June 20.

The Physical Society announces that it has caught up arrears of publication and is able to promise much more speedy publication for papers both in its Section A (atomic and sub-atomic physics) and its Section B (macroscopic physics).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Determination of Carbonic Anhydrase Activity

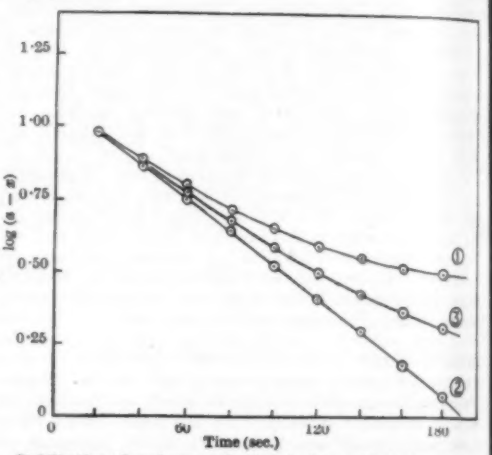
In a recent paper, Wilbur and Anderson[1] have compared the electrometric and colorimetric methods of determining carbonic anhydrase activity. They have confirmed an observation first made by Kiese and Hastings[2] that indicators can inhibit the enzyme and introduce a source of error into the Philpot and Brinkman techniques. They maintain, therefore, the superiority of the electrometric method. However, it must be pointed out that any procedure which is based on measurements of the time taken to bring about a given change in *p*H, in the presence and absence of the enzyme, is much less reliable than the original manometric method of Meldrum and Roughton[3]. Experiments carried out in this laboratory have indicated that the electrometric method of following the *p*H changes is unsatisfactory when different substances are being tested for activating effects. Some of the errors are almost certainly due to interference with the rapid establishment of equilibrium between the glass electrode and the medium. Besides, there is always the possibility that the effects of activators and inhibitors depend on the *p*H at any given instant. For example, in a 4-ml. solution containing 4·5 units of carbonic anhydrase (activity = 160 units per mgm.), bromothymol blue at a concentration of 2·5 mgm. per cent inhibits by more than 45 per cent at *p*H 6·8 but only by 25 per cent at *p*H 7·5. It is suggested, therefore, that the 'boat' method must remain the standard procedure, particularly in work dealing with activators and inhibitors.

The criticisms which have been made of the manometric method, namely, the limiting effect of diffusion and the inactivation of the enzyme by the violent shaking, can be met by: (*a*) working only within a concentration-range where there is strict proportionality between the amount of enzyme added to the boat and the observed activity, and (*b*) by using the unimolecular velocity constant as a measure of the activity. To determine whether inactivation has taken place or not, it is merely necessary to plot log $(a - x)$ as a function of time. If a straight line is obtained, then no inactivation occurred, and the slope of the line is directly proportional to the velocity constant. If there is marked deviation from linearity, on the other hand, then it is necessary to calculate several values of K from the equation for a first-order reaction:

$$K = \frac{2{\cdot}3}{t} \log \frac{a}{a - x},$$

and to extrapolate back to zero time to find the true, initial velocity constant. The activity can be expressed simply as the difference between the constants for the catalysed and uncatalysed reactions, or a unit may be calculated in the way described by Mitchell, Pozzani and Fessenden[4].

When working with lysed red cells, inactivation does not occur to any appreciable extent owing to the large amount of non-enzyme protein present which can act as a protecting agent. However, with semi-pure solutions, or even the crude chloroform preparation, the inactivation in the boat is considerable; but by following the procedure of Scott and Mendive[5] and adding peptone, it can be prevented. It should be noted that the peptone merely stabilizes the enzyme. It does not alter the initial slope of the graph of log $(a - x)$ against time, and is therefore not an activator (see graph). For freshly diluted enzyme solutions, 0·05 per cent peptone is sufficient to prevent inactivation; but after standing for twenty-four hours, even in the presence of this amount of peptone, the carbonic anhydrase appears to undergo some change. Although the velocity constant at zero time remains the same, the sensitivity to inactivation increases. To obtain a straight-line graph again, the concentration of peptone must be increased.



Stabilization of semi-pure carbonic anhydrase with 0·05 per cent peptone. Curve 1: enzyme diluted with distilled water. Curve 2: enzyme diluted with peptone. Curve 3: enzyme diluted with peptone but allowed to stand 24 hr. at 1° C. before being tested

The sensitivities of different preparations may be compared by calculating the percentage decrease in the value of the unimolecular velocity constant during the first 100 sec. of the reaction. This decrease is represented by the symbol D. In a similar way the ability of an agent to protect the enzyme can be determined. The degree of stabilization, S, is calculated as 100 $(1 - d/d')$, where d and d' are the values of D in the presence and absence of the stabilizing agent respectively. Examples of the use of these figures are given in the table.

When studying the action of inhibitors on semi-pure enzyme preparations, it is essential to make allowance for any stabilization that may be brought about. To take again the case of bromothymol blue,

Inactivation and stabilization of carbonic anhydrase; carbon dioxide output at 0° C.; boats shaken at 350 cycles per min.

Enzyme preparation	Stabiliser	*D* (per cent)	*S*
Lysed red cells, 1 : 1,500	—	3	—
Crude enzyme (160 units per mgm.)	—	15	—
Semi-pure enzyme (1,750 units per mgm.)	—	35	—
" " "	0·01 *M* cysteine	27	23
" " "	4·0 m*M*. histamine	18	49
" " "	1 : 5,000 adrenaline	15	57
" " "	5 mgm. per cent bromothymol blue	8	77
" " "	1 : 40 horse serum	0	100
" " "	0·05 per cent peptone	0	100

although 2·5 mgm. per cent can inhibit carbonic anhydrase by nearly 50 per cent, it can also stabilize the enzyme. Now even a slight degree of stabilization means that the enzyme will act catalytically in the host for a longer period of shaking. Hence any estimation of activity which is based on the total amount of gas liberated over a given period may be very much in error. It is even possible for the stabilization to be so pronounced that such a method of estimation would indicate some degree of 'activation', whereas there was actually an inhibition. This kind of error is readily avoided by using the unimolecular velocity constant in the manner described.

This work has been carried out during the tenure of an 1851 Exhibition Research Scholarship. My thanks are due to Mr. Levenbook for assistance with the electrometric experiments.

A. M. Clark

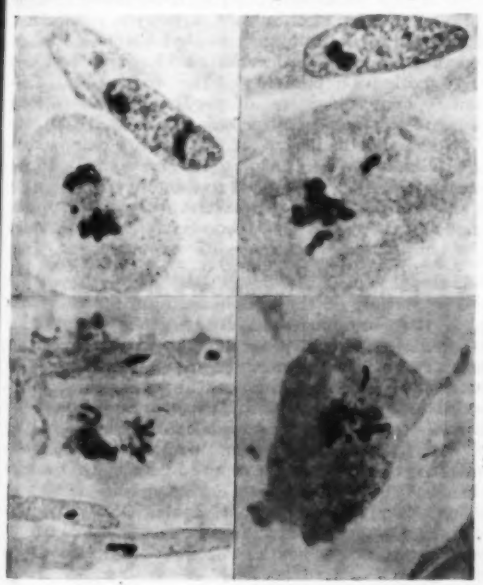
Molteno Institute,
Cambridge.

[1] Wilbur and Anderson, *J. Biol. Chem.*, **176**, 147 (1948).
[2] Riese and Hastings, *J. Biol. Chem.*, **132**, 281 (1940).
[3] Meldrum and Roughton, *J. Physiol.*, **80**, 113 (1934).
[4] Mitchell, Pozzani and Fessenden, *J. Biol. Chem.*, **160**, 283 (1945).
[5] Scott and Mendive, *J. Biol. Chem.*, **139**, 661 (1941).

Effect of Urethane Combined with X-Rays on Chick Fibroblasts

The similarity of action between urethane (ethyl carbamate) and X-rays suggests that a common mechanism of action may be present. The similarity has been seen in several ways. For example, both agents have been found to inhibit mitosis, the arrest primarily affecting the prophase stage of division. The similarity is also seen in the clinical treatment of human leukæmia, where the effects of X-rays and of urethane seem indistinguishable.

We have also found that chick fibroblasts treated with urethane show chromosome fragmentation and 'stickiness' resembling closely the appearances produced by X-rays; see accompanying photographs of cells fixed after an 80-min. exposure to 0·2 per cent urethane. Chromosome abnormalities have previously been reported for plant material by Oehlkers[1].



It might be expected that, if the two agents acted through a similar mechanism, a combination of urethane and X-rays would have a greater effect than that of either agent used alone. This has been tested and is not the case. Using the inhibition of mitosis in fibroblasts as a criterion, it has been found that the effect of a dose of 30 r. X-rays is diminished if urethane is added to the culture medium in a concentration of 0·1 per cent, which would itself reduce mitosis significantly. The reduction found with the combined treatment is less than that produced by X-rays alone, but is usually greater than that produced by urethane in the concentration used. The reduction occurs whether urethane is added before or up to a period of at least 40 min. after the irradiation. This diminished effect is also reflected in a lowered number of chromosome aberrations found as a result of the combined treatment.

In view of the possibility that the findings might depend on a shift of the mitotic cycle giving the appearance of diminished effect, experiments have been made using the criterion of delayed lethal action on fibroblasts. A dose of 6,000 r. was given in fractions. Just before each irradiation session, a solution containing 0·2 per cent urethane in Tyrode was added to the medium. Cultures so treated showed a significantly higher survival-rate than those treated with Tyrode solution and X-rays.

Three conclusions seem to be justified: (1) X-ray action is incomplete at the time of irradiation, and is capable of being reversed at least in part up to a considerable time after it has been administered. (2) While urethane by itself produces effects characteristic of X-rays, it also can partially reverse an X-ray effect when the two agents are combined. This finding does not necessarily prove that the action of the two agents is exerted on a different chain of events in the cell, but it suggests this possibility. The experiments could, however, be interpreted on a hypothesis that the mechanism was the same but that the diminution of X-ray effect following urethane was due to a separate property of urethane, possibly the depression of respiration. (3) The experimental evidence provides no basis for expecting that an augmented effect would be obtained in the treatment of leukæmia by the simultaneous use of X-rays and urethane.

The detailed experiments will be published elsewhere.

Edith Paterson
Mary V. Thompson

Department of Radiobiology,
Christie Hospital and Holt Radium Institute,
Manchester 20. Oct. 6.

[1] Oehlkers, F., *Z. indukt. Abstam. und Vererb.*, **81**, 313 (1943).

A New Method for Determining the Weight of Cellular Structures

Substitution of a continuous spectrum for monochromatic X-rays in the methods now being used for cytochemical elementary analysis[1,2] makes it possible to weigh single cell structures when a sufficiently broad band of a continuous X-ray spectrum is used. The effects of the absorption jumps of the elements in the tissue can be neglected, and the total absorption is proportional to the total mass of tissue. The wave-lengths of the chosen band must be selected properly.

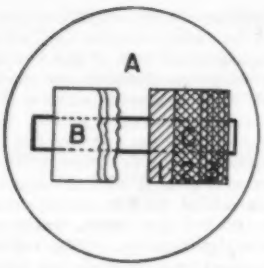
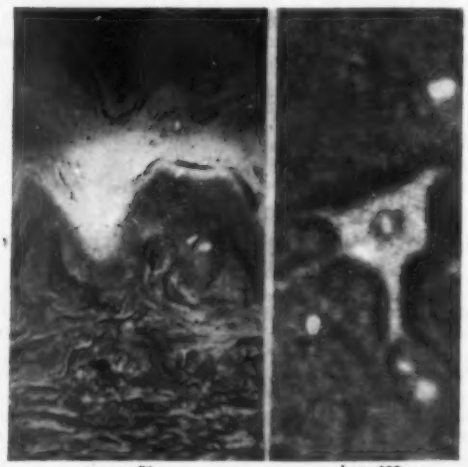


Fig. 1

A thin collodion foil (c. 0·3 μ), laid over the slit in the metal preparation holder *A*, serves as supporting membrane for the preparation. The microtome section or a smear of the tissue being examined is laid on one half of that membrane (*B*). The other half of the membrane (*C*) is reserved for an absorption wedge made of thin collodion foils (Fig. 1). The X-ray absorption of the foils should be of the same order as that of the sample. The preparation is laid against the photographic emulsion of a Lippmann-film or any other very fine-grained photographic emulsion. Very good contact must be secured. A microradiogram is registered with long wave-length continuous X-rays (500–4,000 volts). The voltages chosen depend on the nature of the sample. The X-ray image of the sample and the wedge is enlarged 200–500 times by photomicrography. Absorption in single cell structures can be compared with the absorption in the collodion foils, and the relative distribution of the amount of dry substance in the sample can be computed by photometric measurements on the enlarged image.

Knowing the weight per unit surface of the collodion foil and introducing a correction factor, the absolute weight per unit surface of the cell structures can be calculated. It is possible to weigh structures as small as 1 μ in diameter, which is the resolving power of the Lippmann-film.

In Fig. 2 photomicrographs of two microradiograms are shown. The radiomicrograms were taken with a voltage of 3,000 volts on the X-ray tube, and the radiation was filtered through aluminium 9 μ thick. Fig. 2*a* shows a section of skin and Fig. 2*b* a section of nerve tissue. In the skin preparation, an area in the outer layer (stratum corneum) was found to have $6{\cdot}4 \times 10^{-6}$ μgm./μ² of dry substance, a similar area in the inner layer of the epithelium $4{\cdot}3 \times 10^{-6}$ μgm./μ² of dry substance. For the nerve cell in Fig. 2*b*, corresponding figures are for the cytoplasm $1{\cdot}8 \times 10^{-6}$ μgm./μ², for the nucleus $0{\cdot}9 \times 10^{-6}$ μgm./μ² and for the nucleolus $1{\cdot}6 \times 10^{-6}$ μgm./μ².



a, × 70 *b*, × 400

Fig. 2

This method is now being used in combination with X-ray methods for quantitative estimation of single elements[1,2] to arrive at elemental analyses referred to a dry-weight basis. Also, planimetric methods may be used to obtain total dry weight of cell parts. Concentrations could be estimated where section thickness is known with sufficient accuracy.

A. Engström
B. Lindström

Department for Cell Research,
Karolinska Institutet,
Stockholm.
Oct. 14.

[1] Engström, A., *Acta Radiol.* (Stockholm), Supp. lxiii (1946); *Nature*, **158**, 664 (1946).
[2] Engström, A., and Lindström, B., *Experientia*, **3**, 191 (1947).

Chlorophorin, a Constituent of Iroko, the Timber of *Chlorophora excelsa*

Iroko, the decay-resistant timber of a tropical African tree, *Chlorophora excelsa*, contains 2–8 per cent of an amorphous phenol, m.p. 157–159°, which can be extracted by ether and has not hitherto been isolated. We propose for this substance the name 'chlorophorin'; analyses of the crystalline tetra-acetate, tetramethyl and tetraethyl ethers agree most closely with the molecular formula $C_{25}H_{36}O_4$.

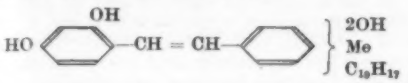
The presence of two double bonds is shown by the catalytic reduction of both chlorophorin and of its tetramethyl ether to tetrahydro compounds. Ozonolysis of the tetramethyl-tetrahydro-chlorophorin resulted in the isolation of two carbonylic products, of which the lower boiling, a methyl ketone (iodoform reaction), gave a semicarbazone identical with that of 6-methyl-2-heptanone. The oxime and 2 : 4-dinitrophenylhydrazone of the less volatile ketone indicate its molecular formula to be $C_{11}H_{24}O_2$.

From an oxidation of tetrahydro-chlorophorin with alkaline hydrogen peroxide, an acid, $C_{11}H_{18}O_2$, was obtained, also ozonized to 6-methyl-2-heptanone. Evidence from the ultra-violet spectrum suggests that the C=C and C=O bonds of the C_{11} acid are not conjugated, and hence its structure is

$$HO_2C.CH_2CH : C(Me)(CH_2)_3CHMe_2.$$

The nature of the aromatic fragment of chlorophorin is demonstrated by (*a*) the isolation of resorcinol on zinc dust distillation, (*b*) the appearance of 2 : 4-dimethoxybenzaldehyde on ozonolysis of tetramethylchlorophorin and (*c*) permanganate oxidation of the tetramethyl ether to 2 : 4-dimethoxybenzoic acid and an aromatic *di*carboxylic acid, $C_{11}H_{12}O_6$. The latter contains the two remaining methoxyl groups, and appears to be a methylbenzene dicarboxylic acid and not a carboxyphenylacetic acid. Thus, two monocarboxylic acids, $C_{10}H_{12}O_4$, m.p. 119–120° and 208–211° (methyl ester 99·5–100·5°), are obtained on heating in quinoline with copper powder.

Chlorophorin, therefore, appears to be a stilbene derivative (cf. pinosylvin[1]), to which the following partial structure can be assigned.



The aliphatic side-chain, $C_{19}H_{17}$, contains two double bonds, one of which is reduced (in addition to that present in the stilbene residue) on catalytic hydrogenation, giving the substituent $—CH_2CH : C(Me)(CH_2)_3CHMe_2$.

M. F. Grundon
F. E. King

Dyson Perrins Laboratory,
University, Oxford.
University, Nottingham.
Feb. 16.

[1] Erdtman, *Ann.*, **539**, 116 (1939).

Formation of Trivalent Cobalt Complexes in Protein Hydrolysates

E. Lester Smith[1], and later E. L. Rickes *et al.*[2], have reported that the pure anti-pernicious anæmia principle (vitamin B_{12}) isolated by them[3,4] was a cobalt complex, containing as much as 4 per cent cobalt dry weight. Immediately after we had been informed about this extraordinary fact by Dr. Lester Smith of Glaxo Laboratories[5], we started the present investigation. We were able first to show that all the amino-acids available to us (see table), with the exception of tryptophane, when treated with cobalt (II) chloride and hydrogen peroxide under suitable conditions, gave solutions the colour of which showed much resemblance to that of a sample of Lester Smith's preparation.

Amino-acid	Colour developed with Co (II) chloride + H_2O_2
Glycine	Purple
dl-Alanine	Purple
dl-Valine	Purple
l-Cystine	Purple
dl-Threonine	Purple
l-Glutamic acid	Purple (weak)
dl-*nor*Leucine	Purple
dl-*iso*Leucine	Purple
dl-Leucine	Purple
dl-Lysine	Purple
l-Arginine	Purple
dl-Asparagine	Purple
dl-Aspartic acid	Purple
dl-Phenylalanine	Purple (faint)
dl-Tyrosine	Purple (very faint)
l-Tryptophane	Yellow
l-Proline	Purple
l-Histidine	Purple

Afterwards we were able to show that, on treating slightly acid protein hydrolysates with cobalt chloride and hydrogen peroxide, solutions of a dark mahogany colour were obtained. This coloured material could not be dialysed through 'Cellophane' membranes. By applying the procedure of Laland and Klem[6] for the purification of the anti-pernicious anæmia factor, we were able to show that the colour passed into the phenol, and from the phenol back into the aqueous phase when four volumes of ether were added. From the slightly acid solution the coloured complex was adsorbed to charcoal, and could not be eluated either by 6 per cent phenol–water or by 96 per cent ethanol. All the coloured material could be removed by glacial acetic acid, and from this it could be precipitated as a pinkish powder by ethyl ether. This powder is easily soluble in water, yielding a purplish-brown solution.

Later, we were able to show that when a protein, for example, casein, is treated with papain and cobalt chloride at neutral reaction, most of the cobalt is bound by the casein, which does not seem to be attacked by the papain under the conditions stated. If one then digests the cobalt–casein complex by means of trypsin, the complex goes into solution, while most of the casein remains undigested. This coloured complex, too, is easily soluble in phenol. The sequence of these procedures may also be reversed, the casein being first digested with trypsin, and then the hydrolysate treated with papain and cobalt chloride for 24–48 hours at 37° C. In this case also a similar complex is obtained.

When using meat as a starting material, much of the colour is not adsorbed by charcoal, and some of it may also be removed by treating charcoal adsorbate with 6 per cent phenol–water. The material which goes into the filtrate is precipitated by ethanol, and may be transformed into a powder with a pinkish hue by washing repeatedly with 96 per cent ethanol and finally with ether.

A few of our fractions have been subjected to clinical trial with respect to anti-pernicious anæmia potency. So far, only a weak reticulocyte response (up to 4 per cent) but no marked effect upon the red count or the hæmoglobin have been observed. Further trials are in progress.

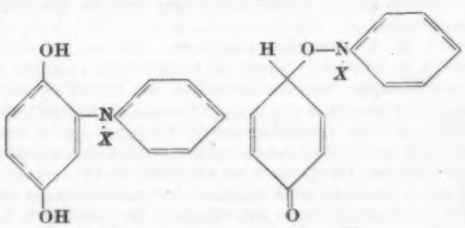
Per Laland
Karl Closs

Research Laboratories,
Nyegaard and Co., A/S,
Oslo.
Sept. 28.

[1] Smith, E. Lester, *Nature*, **162**, 144 (1948).
[2] Rickes, E. L., Brink, N. G., Koniuszy, F. R., Wood, T. R., and Folkers, K., *Science*, **108**, 134 (1948).
[3] Rickes, E. L., *et al.*, *Science*, **107**, 396 (1948).
[4] Smith, E. Lester, *Nature*, **161**, 638 (1948).
[5] Private communication.
[6] Laland, P., and Klem, Aa, *Acta Med. Scand.*, **88**, 620 (1936).

A Quinonoid Structure for Hydroquinone Pyridinium Salts of Organic Acids

Hydroquinone pyridinium salts of organic acids, for example, formate and acetate, were prepared by the action of pyridine on *p*-quinone in presence of formic or acetic acid[1]. These salts are found by analysis not to contain active hydrogen. They are not methylated by diazomethane or dimethyl-sulphate, nor acetylated by acetic anhydride; and in all these experiments the materials were recovered almost unchanged. So far as could be ascertained from the literature, the preparation of such derivatives has not hitherto been attempted.



(I) (II)

(X = H.COO, CH_3COO)

Formula (II) is suggested instead of formula (I) given earlier[1,2,3]. It not only explains the above experimental facts, but also the deep colours of these salts (formate, orange; acetate, deep brown). Moreover, these compounds were found to give pyridine easily on hydrolysis with alkali or by oxidation with potassium permanganate. This is in support of (II), in which the linkage of the pyridine residue is through an oxygen.

An attempt was made by Schönberg and Ismail[4] to occupy the four positions in *p*-quinone and to see whether compounds of the same type are formed. They used tetrachloro- and tetrabromo-*p*-quinone; but the result was partial or complete dehalogenation by means of pyridine in presence of organic acids or water respectively.

Experiments are now being carried out on substituted *p*-quinones in which the substituent groups are non-reactive; for example, mono-, di-, tri- and tetramethyl-*p*-quinones.

ABDEL FATTAH ALY ISMAIL
Faculty of Science,
Farouk I University,
Alexandria.
Sept. 28.

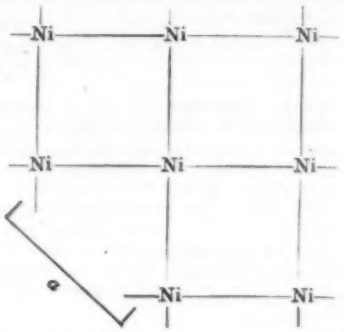
[1] Buchta, *Ber.*, **70** (B), 2339 (1937).
[2] Barnett, Cook and Peck, *J. Chem. Soc.*, **125**, 1035 (1924).
[3] Diels and Kassebart, *Ann.*, **530**, 51 (1937).
[4] Schönberg and Ismail, *J. Chem. Soc.*, 1374 (1940).

Clathrate Compound Formed by Benzene with an Ammonia–Nickel Cyanide Complex

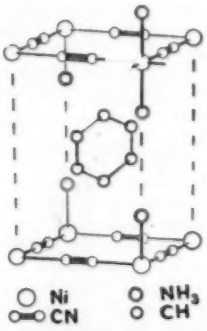
THE clathrate type of molecular compound is formed by the imprisonment of one sort of molecule in some kind of cage structure of the other component. In the compound CM the molecular component M is trapped during formation of the cage C from molecules or other complexes which exist in the same solution with it. Although certainty may be attained only by exact structural investigations, it is possible to make a preliminary assignment of a particular molecular compound to this class on general grounds.

In such a compound (*a*) there is no apparent means of linking C and M, (*b*) the part C must somehow be capable of cage formation, (*c*) M will be replaceable by other molecules that fit into the cages but not by chemically allied compounds if their molecules are of unsuitable size, (*d*) there is a limiting composition determined by the ratio of cage-forming material C to the number of cavities available to contain M, but the composition may vary, for example, through some cavities being unoccupied.

The series of compounds formed from ammoniacal nickel cyanide solution and a small group of organic substances fulfils these conditions and is therefore being examined. The composition is $Ni(CN)_2.NH_3.M$, where M is benzene, thiophene, furane, pyrrole, aniline or phenol[1]. There is no obvious manner in which benzene may be linked to the nickel cyanide complex (condition *a*). As previously explained[2], the metal —C≡N— metal sequence of atoms, which may well be suspected in the cyanide complex, is a suitable cage-forming component as required in (*b*). Homologues of benzene and of the other molecules do not form such compounds as explained by condition (*c*), and the compound may, in fact, be used for the estimation of benzene in the presence of its homologues. The thiophene compound has only about a third of the thiophene indicated by the formula; this behaviour could be explained by condition (*d*).



Examination by X-ray methods of the crystalline benzene compound reveals the structure shown in the accompanying figure. The unit cell is tetragonal with approximate dimensions $a = 7{\cdot}2$, $c = 8{\cdot}3$ A., and contains atoms corresponding to twice the formula $Ni(CN)_2.NH_3.C_6H_6$. Direct Fourier F synthesis based on signs derived from atoms in fixed positions locates the other atoms. The main component of the structure is an extended two-dimensional array of —Ni—CN—Ni— groups which form a flat network.



Part of the structure to show the surroundings of one benzene molecule. The *c* axis is vertical, *a* lies along the base diagonal

To every other nickel atom there are attached two ammonia groups projecting above and below the network. It is probable that one set of nickel atoms is surrounded by carbon only and the other by nitrogen.

This complex fulfils the requirements for cage formation in one of the simple ways envisaged in the original discussion of clathrate compounds[3]. It has a rigid structure with projecting fixed side-groups which prevent the close approach of two such complexes. Although staggering of these side-groups would make possible closer packing than that shown in the figure, no arrangement can avoid a considerable amount of empty space owing to the fixed form and dimensions of the nickel complex. The packing shown is stabilized by the inclusion of a benzene molecule in each of a set of cavities left between layers, and the structure as a whole is well packed.

The lowest interatomic distances between any benzene carbon atom and an atom of the surrounding cage are about 3½ A.; but any attempt to remove a benzene molecule brings it much closer to cage atoms. A nickel atom of either kind has eight benzene molecules which are equally its neighbours. There is no possibility of any form of chemical linking between nickel and particular atoms of benzene. The planes of the benzene molecules are at right angles to those of the nickel cyanide layers. Any general form of intermolecular attraction directed at right angles to the benzene hexagons would therefore not explain its attachment to the nickel complex. These results, therefore, confirm the assignment of this compound to the clathrate type. The specific character of ammoniacal nickel cyanide as a means of estimating benzene is thus explained; and when further studies of the volume conditions in these structures have been made, it may be possible to make similar materials capable of compound formation with the homologues.

Much information on the nature of the nickel complex can be derived from the fine details of the X-ray diffraction pattern and will be considered elsewhere.

H. M. Powell
J. H. Rayner

Laboratory of Chemical Crystallography,
University Museum,
Oxford.

[1] Hofmann, K. A., and Höchtlen, F., *Ber.*, **36**, 1149 (1903). Hofmann, K. A., and Arnoldi, H., *Ber.*, **39**, 339 (1906).
[2] Powell, H. M., *J. Chem. Soc.*, **61** (1948).

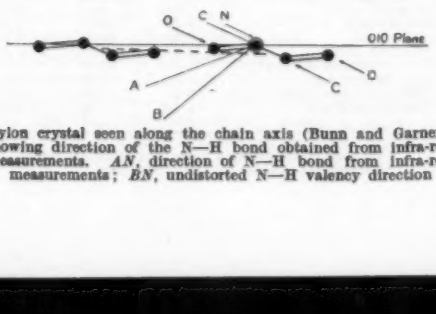
Double Orientation and Infra-Red Dichroism in Polymers

In continuation of our studies on the orientation of polymer molecules[1], we have examined several rolled polymer sheets with polarized infra-red radiation using a selenium polarizer[2] and a lithium fluoride prism to give high dispersion in the 3-micron region.

Double orientation has been observed by Bunn and Garner[3] in X-ray photographs of rolled sheets of nylon. We have detected double orientation in nylon and polyvinyl alcohol by examining the spectrum of the rolled material with polarized infra-red radiation passing through the material at an angle of 54° to the plane of the sheet.

The phenomenon is most marked in the case of nylon, where, with suitable orientation of the material, the symmetrical and antisymmetrical CH_2-stretching m[illegible]es are found to have a change of dipole moment respectively in, and perpendicular to, the plane of the sheet. Glatt and Ellis[4], working in the overtone region, were unable to detect this effect. They suggest that their result may have been due to the rolling technique employed, which produced insufficient orientation, and this appears to be the case.

From quantitative measurements with polarized radiation, it appears that the direction of change of dipole moment in the N—H bond makes the same angle to the 010 plane of the nylon crystallite as does the axis of the C—H_2 group. The axis of the C—H_2 group lies in the plane of the carbon chain. From the diagram given by Bunn and Garner[3], it is possible to estimate the various angles, and it appears that the plane of the carbon chain makes an angle of about 22° with the 010 plane. The N—H bond, therefore, makes an angle of about 22° with the 010 plane. The sense of this angle is not known from infra-red measurements, since the nylon crystallites are oriented in two- but not in three-dimensions. It is reasonable, however, to assume that the N—H bond will be on the same side of the carbon chain as the neighbouring C=O on the same chain. This arrangement allows the hydrogen bonding between adjacent chains to take place with the least deformation of the N—H bond. If this is the case, since the C=O makes an angle of about 4° to the 010 plane[3], then the angle between the C=O and N—H bonds is about 18°, and has been reduced by the hydrogen bonding forces from 39° (corresponding to the nitrogen valency angle).



Nylon crystal seen along the chain axis (Bunn and Garner), showing direction of the N—H bond obtained from infra-red measurements. *AN*, direction of N—H bond from infra-red measurements; *BN*, undistorted N—H valency direction

In hot-rolled sheets of polyvinyl alcohol, the CH_2 stretching frequencies show the same evidence of double orientation as in nylon, though to a smaller extent. This shows that there is a tendency for the planes of the carbon chains to be oriented parallel to the rolled sheet, as would be expected from the structure for the polymer proposed by Bunn[5].

Although considerable dichroism is shown by the CH_2 frequencies, the very broad O—H band shows no dichroism whatever, whether the radiation be normal to the rolled sheet or inclined so as to approximate to the direction of the extended polymer chains. This is entirely in agreement with Bunn's structure[5] and is conclusive evidence that the earlier views of Mooney[6] are incorrect; for if the O—H bonds were confined to the plane of the carbon chain, as Mooney proposed, strong dichroism of the O—H bands should appear when the radiation direction approximates to the chain direction. Our earlier results, obtained with infra-red radiation normal to the stretched polymer[1], did not discriminate against the structure proposed by Mooney.

A. Elliott
E. J. Ambrose
R. B. Temple

Research Laboratory,
Courtaulds, Ltd.,
Lower Cookham Road,
Maidenhead, Berks.
Sept. 29.

[1] Elliott, A., Ambrose, E. J., and Temple, R. B., *J. Chem. Phys.*, **16**, 877 (1948).
[2] Elliott, A., Ambrose, E. J., and Temple, R. B., *J. Opt. Soc. Amer.*, **38**, 212 (1948).
[3] Bunn, C. W., and Garner, E. V., *Proc. Roy. Soc.*, A, **189**, 39 (1947).
[4] Glatt, L., and Ellis, J. W., *J. Chem. Phys.*, **16**, 551 (1948).
[5] Bunn, C. W., *Nature*, **161**, 929 (1948).
[6] Mooney, R. C. L., *J. Amer. Chem. Soc.*, **63**, 2828 (1941).

Reactions in Liquid Sulphur Dioxide

Jander's theory[1] of reactions in liquid sulphur dioxide has recently been criticized by Bateman, Hughes and Ingold[2] and, in this connexion, it appeared that some useful information might be obtained by determining whether or not exchange of oxygen occurred between liquid sulphur dioxide and a dissolved alkali sulphite labelled with heavy oxygen. Jander's theory would necessarily require an ex-

change to occur. Preliminary work on this problem indicated a discrepancy between the solubility of sodium sulphite given by Jander and that determined by ourselves. It was decided, therefore, to check the solubilities of several other salts.

Particular attention was paid at all stages of the work to exclude possible contamination of the liquid sulphur dioxide with water, except where that was required. The sulphur dioxide was prepared from sodium sulphite and stored in contact with phosphorus pentoxide in a tube which was rotated end over end for the stated drying periods. The solubility vessel containing the salt under investigation was pumped out to a good vacuum while being heated to about 130° C. for one hour before introduction of the sulphur dioxide. All transfers of sulphur dioxide were carried out *in vacuo*, and connexion to the vacuum system was made through breakable glass seals.

In the early experiments, we used a glass-wool plug, as Jander did, to separate the saturated solution from the excess solid, but later replaced this by a sinter-glass filter because we found, on occasions, that fine particles of solid were carried through the glass-wool plug. The solubility tube finally took the form of a right-angle bend with the sinter-glass filter at the bend. In this form, the saturated solution in contact with excess solid in one arm could be filtered into the other arm, and afterwards the sulphur dioxide could be distilled back into the original arm, leaving behind any salt which had been dissolved. Generally about 60 gm. of sulphur dioxide was introduced into the solubility tube and transferred from one side to the other from two to six times. Measurements were carried out at 0° C., and the liquid sulphur dioxide was shaken in contact with the solid for about twenty-four hours before filtration.

Experiment number	Substance	Time of drying SO_2	Solubility (gm./100 gm. SO_2)	Jander's result (gm./100 gm. SO_2)
1–8	Na_2SO_3	0–14 days	Infinitesimal	0·026
9–10	K_2SO_3	0–28 days	,,	0·035
11	$Na_2S_2O_5$	7 days	,,	0·026
12	$K_2S_2O_5$	14 days	,,	0·035
13	$(NH_4)_2SO_3.H_2O$	28 days	,,	0·048
14	$NaHSO_3$	3 days	,,	Not quoted
15	Na_2SO_4	28 days	,,	Practically insoluble
16	KCl	28 days	0·013	0·041
17	,,	14 days	0·021	,,
18	,,	1 day	0·030	,,
19	,,	5 days	0·026	,,
20	,,	7 days	0·026	,,
21	,,	8 days	0·029	,,
22	,,	—	0·048	,,
23	NaCl	Indefinite	0·0003	0·016
24	,,	5 days	0·0001	,,
25	$[N(CH_3)_4]_2SO_3$	—	20·0	Easily soluble

Where the solubility is stated to be infinitesimal, it is approximately of the same order as that of sodium chloride. In experiment Nos. 5, 6, 10 and 22, the sulphur dioxide contained 0·07, 0·64, 0·084 and 0·284 per cent by weight of water respectively.

Jander states that sulphites in contact with liquid sulphur dioxide are converted to the metabisulphites, and, for this reason, he quotes figures for the solubilities of sulphites in terms of metabisulphites. We have been unable to verify this statement from our solubility measurements for the alkali metal sulphites or metabisulphites because of the extremely small solubilities of the substances concerned.

The high solubility of $[N(CH_3)_4]_2SO_3$ is apparently due to the formation of some complex, as the solution had a deep orange-red colour. On removal of the sulphur dioxide by cooling one side of the solubility tube to − 80° C., a colourless solid corresponding to $[N(CH_3)_4]_2S_2O_3$ remained behind.

Our data for potassium chloride suggest that the solubility of this salt is considerably influenced by the degree of drying of the sulphur dioxide. The solubilities of alkali metal halides in liquid sulphur dioxide at 25° C. have been determined by Schattenstein and Wiktorow[3]. For potassium and sodium chloride they obtained 0·0127 and 0·0004 (gm./100 gm. sulphur dioxide) respectively. These values agree reasonably well with ours.

In conclusion, it may be mentioned that the possibility of exchange of oxygen between liquid sulphur dioxide and sulphuryl chloride is being investigated, and it is proposed to use $[N(CH_3)_4]_2SO_3$ to study the exchange reaction mentioned at the beginning of this note.

I. Lauder
E. Rossiter

Department of Chemistry,
University of Queensland,
Brisbane.
Sept. 30.

[1] Jander and Wickert, *Z. physik. Chem.*, A, 178, 57 (1936). Jander and Ruppolt, *Z. physik. Chem.*, A, 179, 43 (1937).
[2] Bateman, Hughes and Ingold, *J. Chem. Soc.*, 243 (1944).
[3] Schattenstein and Wiktorow, *Acta Physicochim., U.R.S.S.*, 7, 883 (1937).

Determination of Keto-Acids by Partition Chromatography on Filter-Paper

The method used by Consden, Gordon and Martin[1] for the qualitative analysis of amino-acid mixtures, and by Partridge[2] for sugars, employing filter-paper partition chromatography, was applied to the determination of some keto-acids. The keto-acids were characterized as their 2,4-dinitrophenylhydrazone derivatives; this gave the advantage of manipulating coloured compounds, which showed their position on the paper without further development.

For the purpose of characterizing a keto-acid, or a mixture of them, in a biological material, a chart, containing the R_f values of nine pure dinitrophenylhydrazones of different keto-acids, was prepared as a preliminary step. Among the solvents tested (phenol, benzyl alcohol, ethyl acetate, butanol) only butanol has given satisfactory results.

The experimental conditions used throughout the work were as follows. We used Schleicher–Schüll

R_f values of 2,4-dinitrophenylhydrazones of some keto-acids at room temperature

	Butanol	Butanol-ammonia*	Butanol-ethanol†
α-Ketoglutaric acid	0·07	0·05	0·26
Oxaloacetic acid	0·13	0·12	0·28
Glyoxylic acid	0·17	0·24	0·32
Pyruvic acid	0·21	0·35	0·36
Acetoacetic acid	0·26	0·40	0·43
α-Keto-γ-methiobutyric acid	0·43	0·62	0·55
α-Ketobutyric acid	0·43	0·65	0·53
p-Hydroxyphenylpyruvic acid	0·60	0·64	0·55
Phenylpyruvic acid	0·59	0·80	0·66

* Butanol saturated with 2 per cent ammonia (v/v).
† Butanol 50, ethanol 10, water 40 (v/v).

filter paper No. 597 in strips 2 cm. wide by 50 cm. long. The dinitrophenylhydrazones, dissolved in 0·01 *M* phosphate buffer, *p*H 7·2 (usually 25γ/0·1 ml.), were placed along a transverse line marked with a pencil at a distance of 7 cm. from the top edge of the strip. The solution was dried, while descending from the pipette, by blowing a stream of warm air on to it. The top of the paper was then placed in a vessel containing the solvent, and which was enclosed in a stoppered cylinder. All the remaining conditions were essentially those suggested in the papers cited above. With this procedure we obtained very well-shaped and well-separated spots of the hydrazones of the following keto-acids: α-ketoglutaric, oxaloacetic, glyoxylic, pyruvic, acetoacetic acid; the remaining compounds gave larger spots without the possibility of separating them when in mixture.

We adapted the method also for a quantitative determination. We cut the paper around the spots, extracted the yellow-coloured hydrazone with 10 per cent sodium carbonate, and the red colour which developed after adding a solution of sodium hydroxide was compared photometrically with a standard. We recovered in such a way up to 97 per cent of the hydrazone, with an average of 91 per cent. The proportionality between different quantities was very close.

The complete details of this work will appear later, our present aim being the adaptation of the method to an estimation of keto-acids in biological materials, in normal and pathological conditions.

Doriano Cavallini
Nora Frontali
Giovanni Toschi

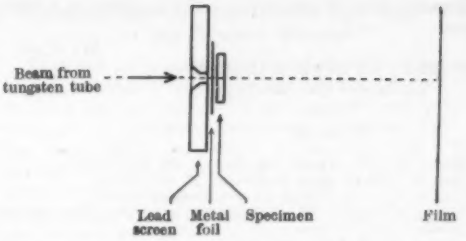
Istituto di Patologia Generale,
C.N.R. Centro di Fisiopatologia,
University of Rome.

[1] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).
[2] Partridge, S. M., *Biochem. J.*, **42**, 238 (1948).

Divergent-Beam X-Ray Photography

Many papers have been published already on this subject—more recently especially by Mrs. Lonsdale[1]. From her investigations it appears that the divergent pattern can give information regarding the perfection of the crystal investigated. As I was interested in differences in perfection between the crystals in recrystallized aluminium, it seemed, therefore, worth while to try to obtain divergent-beam photographs of aluminium single crystals. The methods of Kossel (crystal used as anode in a specially designed X-ray tube) and of Borrmann (fluorescent radiation of the crystal itself) cannot be used in this case (for a review of their work see ref. 2). A point source of characteristic X-ray radiation is therefore necessary, and special X-ray tubes for this purpose have been developed by various investigators. In view of the long time required to construct such a tube, we sought to solve the problem in such a way that a normal sealed-off tube could be used.

The experiments of Borrmann[3] suggested the following procedure (see diagram). The beam of a tungsten tube passes through a tiny hole (φ = 0·3 mm.) in a lead screen. On the other side of the screen a metal foil is placed, and in this foil the characteristic radiation is generated. Because of the very small irradiated



spot, the source of the resulting divergent radiation is fairly point-shaped. On the other side of the foil the divergent characteristic radiation, together with the primary beam, emerges. The crystal is placed in contact with the foil. On the film the Laue transmission pattern and, under favourable conditions, the divergent pattern, are formed.

In the course of our experiments we learned that a paper by Geisler, Hill and Newkirk[4] on divergent-beam photographs had appeared. These investigators took transmission Laue photographs of single crystals of iron or cobalt alloys and observed the divergent pattern on the Laue picture. Apparently the divergent radiation was the secondary radiation of iron or cobalt. This method is closely related to that of Borrmann and had been, in fact, already published by him[5].

For the investigation of other crystals, Geisler, Hill and Newkirk suggested the use of an iron foil, apparently in the same way as has been outlined above. We should like to point out that an iron foil can only be used for the investigation of crystals of very low absorption (for example, organic crystals). The calculations of Mrs. Lonsdale show this clearly.

On the strength of calculations and experiments, it can be shown that for divergent silver *K*-radiation, the optimum thickness of aluminium lies between 1 and 5 mm. and for copper *K*-radiation between 0·05 and 0·2 mm. In our case the thickness of the foil was *c.* 0·03 mm. and exposure times with Ilford film and a 1-kW. tungsten tube were of the order of one or two hours. Up to the present, we have not succeeded in finding the differences between various crystals mentioned above, but the investigations are still in progress. A full account will be published elsewhere in due course.

The investigations are being carried out under the direction of Prof. W. G. Burgers.

Note added in proof. Attention may be directed to the recent paper of Geisler, Hill and Newkirk[6] in which a study is made of several substances by the method outlined above. Dr. Geisler kindly informed me that their experiments were made without prior knowledge of Borrmann's work[3,5,7]. The main purpose was to direct attention to the possibility of obtaining divergent patterns with the commercially available X-ray apparatus. From their paper it will be clear that a considerable amount of information can be gained in this way.

The method can, however, be improved still further by using the technique indicated by Borrmann[7]. The existence of this paper was unknown to me at the time when I wrote the above communication. Specimen and film are mounted in such a way that primary radiation and Laue pattern are avoided on the film. Again, no specially designed apparatus is required. The patterns so obtained are very clear.

Full particulars of the method will be given in a later paper.

W. May

Laboratory for Physical Chemistry,
Technical University,
Delft.
Sept. 20.

[1] Lonsdale, K., *Phil. Trans. Roy. Soc.*, A, **240**, 219 (1947).
[2] Kossel, W., *Erysbn. exakt. Naturwiss.*, **16**, 295 (1937).
[3] Borrmann, G., *Ann. Physik*, **27**, 686, footnote (1936).
[4] Geisler, A. H., Hill, J. K., and Newkirk, J. B., *Phys. Rev.*, **72**, 983 (1947).
[5] Borrmann, G., *Z. Krist.*, **100**, 228 (1939).
[6] Geisler, A. H., Hill, J. K., and Newkirk, J. B., *J. App. Physics*, **19**, 1041 (1948).
[7] Borrmann, G., *Physik. Z.*, **42**, 157 (1941).

Radioactivity of Dust

It is well known that the dust particles contained in moist air streaming with considerable velocity through a small hole towards a plane surface are deposited on it. This effect is currently used to determine the content of dust in the air by means of dust-counters. We thought it would be interesting to investigate in the same way the behaviour of atoms of radon and its disintegration products contained in air.

The dust from air containing $1{\cdot}5 \times 10^{-11}$ curie/c.c. of radon was deposited in the form of a dust spot (Fig. 1) on a glass plate, by aspirating 90 c.c. of this air in an Owens–Běhounek dust-counter[1]. After 10 min. (when most of the radium A had disintegrated) the glass was pressed on the emulsion of an Ilford Nuclear Research plate *C* 1 and left there for an hour. After development of the plate, many tracks of alpha particles could be observed. They are concentrated within a very small region, corresponding exactly to the position of the dust spot (Fig. 2). Range measurement proved that these tracks are due mostly to alpha particles of radium C′.

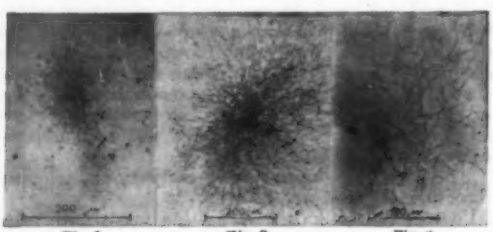


Fig. 1 Fig. 2 Fig. 3

Further experiments have been carried out to decide whether the atoms of the active deposit settle on the glass directly or through the intermediary of the dust particles. When the dust in the aspirated active air was removed by means of a cotton-wool filter, only a few radioactive atoms were deposited on the glass, as can be seen from Fig. 3, obtained with purified air of the same activity as was used in Fig. 2. In further experiments, air containing radon was aspirated into two similar ionization chambers, into the first one directly, and into the second one through a cotton-wool filter. After two hours, when radon was practically in radioactive equilibrium with its disintegration products, the air from both chambers was passed into the dust-counter and photographs of alpha tracks were taken as described above. Only a small fraction of atoms of radium C′ was deposited on the glass from the purified air as compared with the air containing dust.

These experiments suggest that deposition on glass of the atoms of the active deposit from radon is enabled by the presence of the dust in the air; that is, these atoms are at least partially, if not entirely, adsorbed on the dust particles. The fact that some radioactive atoms are deposited even from the purified air can be explained by the presence of submicroscopic dust particles not retained by the filter and settling on the glass with radioactive atoms adsorbed on them. This method could thus serve for detection of submicroscopic particles in the air.

The retention of atoms of the active deposit in the filter was confirmed by the values of the ionization current in the two ionization chambers immediately after the active air was introduced into it; that in the chamber with purified air is only 0·65 of the current in the chamber filled with air containing dust.

It is reasonable to suppose that artificial radioactive atoms, for example, atoms left in the air by the explosion of an atomic bomb, will similarly be adsorbed on dust particles.

I am very grateful to Dr. Běhounek for his valuable discussions and suggestions, and to Prof. Petržilka for supplying Ilford plates.

Č. Jech

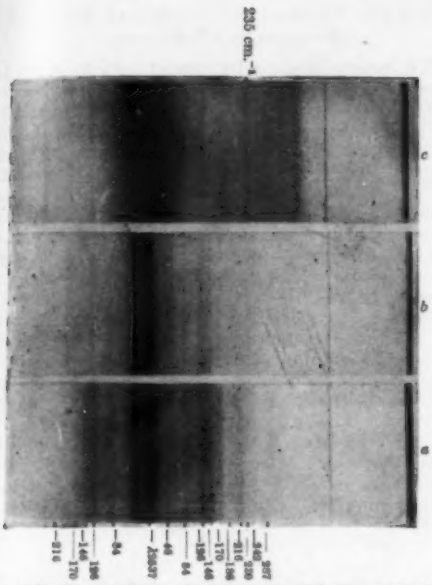
Department of Physics,
Radiotherapeutical Institute,
Praha-Bulovka.
Oct. 15.

[1] Běhounek, F., and Effenberger, E., *Gerlands Beitr. z. Geophys.*, **30**, 74 (1942).

Raman Spectrum of Potassium Bromide

Potassium bromide has a crystal structure similar to that of rocksalt; but as the ions in the former are heavier, the Raman frequency shifts are smaller and hence less easy to record in a satisfactory manner. The success of Menzies and Skinner[1] in observing some detail in the Raman spectrum of the substance, however, encouraged us to undertake an investigation having for its object a fuller elucidation of the nature of this spectrum. For this purpose it is necessary to effect a very perfect elimination of the diffuse continuum of instrumental origin overlaying the Raman lines, and also to use the highest available dispersive and resolving powers. We have paid special attention to these points in our work.

Fig. *a* is a reproduction of a spectrogram obtained by us using the medium Hilger quartz instrument with a very fine slit (0·025 mm.) and an exposure of 24 hours. Fig. *b* was recorded with the large quartz spectrograph and an exposure of no less than 15 days. Unfortunately, in the latter case, as a result of prolonged exposure to the rays of the mercury arc, the crystal acquired a distinct coloration and a diminished transparency, and the spectrum was therefore not recorded with the full intensity hoped for. Nevertheless, on a scrutiny of the recorded spectra it is clear that they consist essentially of a series of discrete Raman lines. These naturally appear more clearly resolved from each other with the more powerful instrument. Indeed, the line character of the Raman spectrum of potassium bromide is not less clearly evident than in the case of rocksalt. The



(*a*) and (*b*) Raman spectra of potassium bromide taken with the Hilger medium and large quartz spectrographs respectively and enlarged to the same extent. (*c*) Raman spectrum of rocksalt taken with the Hilger large quartz spectrograph

spectrum of the latter is reproduced in Fig. *c* for comparison.

A crystal with rocksalt structure has nine eigenfrequencies. These may be evaluated[2] to a first approximation with the aid of two assumed force-constants only. The theoretically computed frequencies for potassium bromide and those evaluated from our spectra are shown for comparison in the accompanying table. It will be seen that the agreement is good.

Force constants: $P = 2{\cdot}22 \times 10^4$ dynes/cm.; $T = -0{\cdot}034 \times 10^4$ dynes/cm.

	ν_1	ν_2	ν_3	ν_4	ν_5	ν_6	ν_7	ν_8	ν_9
Calculated frequencies	121	117	112	104	95	73	67	40	28 cm.⁻¹
Observed frequencies	121	116	114	108	93	73	63	42	23

ν_6 in the table is the frequency of the oscillation of the bromine and potassium ions against each other, and it is in good agreement with the infra-red absorption maximum at 113 cm.⁻¹ recorded by Barnes[3]. As is to be expected in view of the high refractivity of the bromine ions, the two most intense lines in the Raman spectrum are the octaves of ν_6 and ν_7, that is, of the oscillations (alternately in opposite phases) of the bromine layers in the octahedral planes of the crystal in directions respectively normal and tangential to these planes, the intervening potassium layers remaining at rest.

We are indebted to Dr. A. C. Menzies for enabling us to secure some satisfactory specimens of synthetic potassium bromide for our experiments.

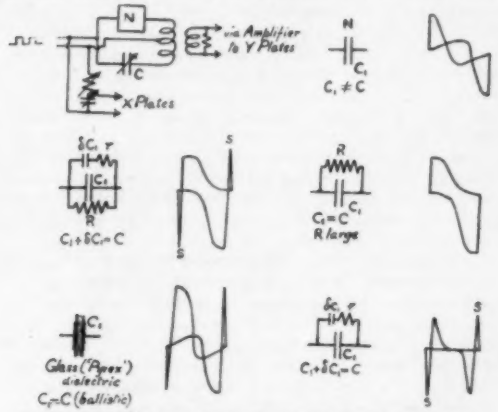
R. S. Krishnan
P. S. Narayanan

Indian Institute of Science,
Bangalore 3.
Oct. 10.

[1] Menzies and Skinner, *Proc. Phys. Soc.*, **60**, 498 (1948).
[2] Raman, C. V., *Proc. Ind. Acad. Sci.*, A, **23**, 370 (1947).
[3] Barnes, B., *Z. Phys.*, **75**, 723 (1932).

Differential Transformer Bridge Operated by Square Waves

The use of inductively coupled ratio arms in a bridge energized by square waves has been studied in these Laboratories, with particular reference to the analysis of condenser-resistance combinations. It has been found, in general agreement with Yates's statement[1], that the output forms shown by a cathode ray oscillograph, as balance is approached, afford a means of discriminating between parallel and series combinations of capacitance and resistance.



Basic bridge circuit, including N, the network under consideration. Typical oscillograms for different networks are shown

The diagrams show the form of the output obtained when certain networks are compared with a variable condenser C. A supply circuit is employed which gives abrupt reversals of potential at a repetition-rate controlled by an audio-frequency oscillator. It will be seen that the association of a series resistance, r, with part of the capacitance, δC_1, gives rise to sharp spikes, s, on the oscillogram; also that similar spikes are present when a glass dielectric condenser is substituted for the four-component network. These spikes are removed when the comparison condenser is reduced by an amount δC_1.

When a potential V is suddenly applied, for the condition $C_1 + \delta C_1 = C$, the current in the two branches divides symmetrically and very rapidly supplies both condensers with charge VC_1. The flow of the remaining charge, $V\delta C_1$, is restricted in one branch by the resistance r, and momentarily an out-of-balance condition exists in which, in effect, the potential across r during the process of charging δC_1 appears at the output, producing the observed spike. Other instances are simpler: with unbalanced pure capacitances, the final flow is restricted by the self-inductance of one branch of the transformer; with a large parallel resistance (L/R small) a small, steady additional current flows in one branch and so opens out the cyclogram.

It has been found possible to ascertain separately the four components of an artificial network of the type shown, and of these components δC_1 is most easily determined. It is hoped that this will be of value in the study of dielectric materials.

W. A. Prowse
Elizabeth Laverick

University Laboratories,
South Road, Durham.

[1] Yates, J. G., *Nature*, **163**, 132 (1949).

Free Barium in and Evaporated from Oxide Cathodes

DURING 1945, in connexion with experiments on thermionic emission from electrodes other than the cathode in small radio valves, we had occasion to make measurements on the quantity of free barium evaporated from the cathode, and also the amount actually adsorbed on or distributed in the barium–strontium oxide coating. In view of the theoretical importance of the latter in connexion with the electrical conductivity of the coating treated as a semi-conductor (investigated by D. A. Wright, whose results are at present in the course of publication), we feel that our results have become of more general interest. Previous measurements by Berdennikowa[1] and Clausing[2] did not distinguish between the barium in the cathode coating and that evaporated, while Prescott and Morrison[3], who made the distinction, used cathodes with free nickel distributed through the coating and activated them in an unusual manner by heating in methane. This may have produced excess barium, which could alloy with the nickel in the coating.

The method of estimation used by us was that of Berdennikowa, to treat the cathode in water vapour and measure the amount of hydrogen produced. The difference between our method and his was that provision was made for dropping the electrode surrounding the cathode, or the cathode, into a side tube attached to the pumping system and sealing the actual valve off, so that only the barium on the appropriate electrode was estimated.

The results given are the mean of six determinations, the probable error being estimated in the usual manner. The barium evaporated from 0·8 sq. cm. of barium–strontium oxide, with an activation of 1 hour at 950° C. approximately and emission current of 50 milli-amp., from cathodes made of different core metals was as follows:

	Commercial 'O' nickel. (Nickel + 0·12 per cent magnesium and traces of other impurities)	Platinum	Nickel + 0·2 per cent silicon	Pure nickel
μ gram (mean)	3·4	0·62	1·6	1·03
Probable error	0·3	0·09	0·23	0·15

The effect of the magnesium and silicon in producing free barium is very apparent from these figures.

The barium content of the coating was measured on cathodes with 0·6 cm.^{2} of coated area and given a similar activation, the core in this case being the 'O' nickel. Total quantity of barium in the coating was 0·4 μgm., with a probable error of 0·07 μgm., which corresponds to 3×10^{15} atoms per cm.^{2}, 3×10^{17} atoms per cm.^{3} or 0·01 per cent by weight of the coating.

This work will be published in more detail elsewhere in due course.

R. O. JENKINS
R. H. C. NEWTON

Research Laboratories,
General Electric Company, Ltd.,
Wembley.
Oct. 14.

[1] Berdennikowa, *Phys. Z. Sowjetunion*, **2**, 77 (1932).
[2] Clausing, "Electron Emission and Adsorption Phenomena", 348 (J. H. De Boer).
[3] Prescott and Morrison, *J. Amer. Chem. Soc.*, **60**, 3047 (1938).

A Simple Method of Producing Wide-Band Frequency Modulation

THE resistance-capacity tuned oscillator is well known as a very good generator of audio-frequency oscillations. In a recent communication by Rakshit and Bhattacharyya[1] it was pointed out that the conventional circuit of a three-phase system, with components selected for producing audio-frequency oscillations, invariably generates radio-frequencies by virtue of the unavoidable stray and inter-electrode capacities. In fact, with the simple three-phase oscillator it is impossible to generate audio-frequencies unless certain modifications are introduced in the circuit. It was further pointed out that the three-phase radio-frequency oscillator can easily be made to generate frequency-modulated oscillations by varying the tuning resistance of one of the oscillator stages by the modulating voltage.

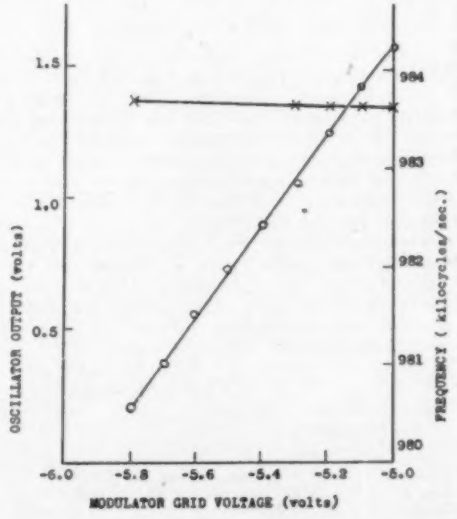
When the three stages of the oscillator are identical, the anode load of each valve being composed of resistance r_1 shunted by capacity c_1 (c_1 includes the stray and inter-electrode capacities involved in the system), it was shown that the oscillations produced are of radio-frequency given by

$$f = \frac{\sqrt{3}}{2\pi c_1 r_1}.$$

If the anode load resistance of any one stage be changed from r_1 to r, without altering any other part of the circuit, the frequency can be shown to change to

$$f_1 = \frac{1}{2\pi c_1 r_1}\sqrt{1 + \frac{2r_1}{r}}.$$

It was therefore suggested in the previous communication that a very simple method of producing frequency modulation would be to shunt any of the three oscillator valves by a triode and apply the modulating audio voltage on the grid of this triode modulator. Faithful modulation would, however, require linearity between change in oscillator frequency and amplitude of modulating voltage. Further, there should not be appreciable amplitude modulation introduced in the process. These conditions have been found to be very closely satisfied



under proper adjustments. The accompanying graph gives the results of a typical set of observations on an oscillator using 6*SK*7 valves; a 6*C*5 valve was used as the modulator. The entire system was very carefully designed, and the voltages to the anode and screen grid were stabilized with voltage regulators. The frequency of the resistance-capacity oscillator was measured by 'beating' it with a conventional quartz-controlled oscillator; it was varied to bring the beat frequency within the audio range, and the variation of this audio-frequency with modulator grid voltage was studied.

It will be seen from the graph that a linear variation of more than 3·0 kc./s. is easily effected. The standard variation for wide-band frequency modulation being ± 75 kc./s. over a carrier frequency generally lying between 40 and 50 megacycles/sec., it would require a linear variation of about ± 1,500 c./s. on a 1-megacycle carrier. The present arrangement accordingly gives quite faithful modulation for the wide-band system. The graph also shows the variation of output voltage of oscillator with frequency. The recorded variation in amplitude over the entire range of linearity is quite small—only 1·5 per cent.

The frequency stability of the resistance-capacity oscillator has been quite satisfactory, and further experiments are in progress to stabilize the central carrier with the help of a discriminator circuit acting in conjunction with a quartz-controlled oscillator.

H. Rakshit
N. Sarkar

Department of Applied Physics,
University of Calcutta,
Calcutta.
Sept. 27.

Ind. J. Phys., **20**, 171 (1946).

Studies on Human Dentine

A DETAILED study of the hydrolysates of human dentine has been carried out here during the last twelve months, using the paper chromatogram technique.

The protein studies on a large series of hydrolysates of sound dentine reveal the consistent absence of either cystine or methionine. Hydrolysates of both sound and carious dentine show a qualitative similarity; but quantitative studies, after water extraction, reveal a definite decrease in the amounts of aspartic and glutamic acids in carious dentine relative to sound dentine. Cold aqueous extracts of sound dentine reveal no amino-acid content, whereas those of carious dentine contain both aspartic and glutamic acids. Neither aspartic nor glutamic acid has been noted in chromatograms of saliva. It has been observed that both aspartic and glutamic acids at low concentrations readily decalcify normal dentine and enamel.

It can therefore be postulated that the carious process may well be a liberation of aspartic and glutamic acids from the protein of the enamel fissure by proteolysing organisms. The acid so formed decalcifies further enamel and dentine, thus freeing more protein. Carbohydrate studies on the chromatogram have so far failed to reveal the presence of either chondroitin sulphate or chondrosamine (although the hydrolyses were carried out in conformity with the studies of Dewar and Percival[1] on the hydrolysis of chondroitin sulphate). The foregoing views are, therefore, contrary to those of Pincus[2,3].

H. F. Atkinson
E. Matthews

Turner Dental School,
University, Manchester.
Oct. 11.

[1] Dewar and Percival, *J. Chem. Soc.*, Pt. II, 1622 (1947).
[2] Pincus, P., *Brit. Dent. J.* (Dec. 1947).
[3] Pincus, P., *Nature*, **162**, 48 (1948).

Mutations by Photodynamic Action in *Bacterium prodigiosum*

IN a previous paper[1] it was shown that dwarf-growth mutants in *Bacterium prodigiosum* (*Serratia marcescens*) can be produced by ultra-violet radiation apparently in a one-hit mechanism, and that the most active wave-lengths lie below 3,000 A. If the killing of bacteria by a light-quantum hit is a process happening in the genetical system, one might suppose that also the energy of quanta of visible light may be capable of producing vital genetic variants, for Liechti *et al.*[2] had observed the killing of vital-stained bacteria by such longer wave-lengths.

Experimental work in this direction seemed interesting because it may be possible in future to determine the threshold energy for a mutation by seeking the superior spectral limit of the mutating light action. In *Bacterium prodigiosum* the potency of visible light in production of dwarf-growth mutants could be demonstrated. Since the bacterial cell evidently does not absorb visible light sufficiently to produce an obvious mutative or killing effect, vital staining with photodynamic active dye (erythrosine) was necessary.

Resting cells were irradiated after staining by projecting the glowing spiral of a 5-volt Osram lamp into the suspension, which was stirred in order to spread the energy homogeneously to all cells. Heat radiation was absorbed by a special glass filter that simultaneously reflected a part of the light at right angles on to a calibrated photo-cell element measuring the radiation energy. After 5, 10, 15, . . . min. of irradiation, 0·5 cm.³ of suspension was diluted in 1/10 steps and one drop plated on a glycerol–citrate–ammonium phosphate agar. After 48 hours of incubation, the total colonies and the dwarf-colony mutants were counted.

The transformed hereditary character of the dwarf-colonies is manifested in later plate-passages only when colonies grow densely enough. If the colony separation is too large, especially at the periphery of the plate, no difference in dimension between normal and mutant colonies can be seen; but often dwarf mutant colonies have a brighter or darker colour. While the survival curve is a straight line in semi-logarithmic co-ordinates, the dose mutation-rate curve has a 'two-hit' character. The ratio of the probability for a killing hit to that for a mutation hit is only 3 : 1, whereas the same fraction for ultra-violet radiation is nearly 150 : 1. Thus visible light is essentially more effective in producing mutations than ultra-violet.

The cause of the different influence of short and long wave-lengths may be a difference in the structure between the vital 'genes' and the units for inhibition of cell-fission. A similar λ-relation in lethal and vital

(mutative) effects for ultra-violet and X-rays was found by Demerec *et al.*[3] for the irradiation of *E. coli*. The killing efficiency of shorter waves is also greater. One might think that lethal centres require greater energy quanta than 'genes'; but then it is not clear why with visible light a mutation is made by two hits, while a killing process requires only one. Perhaps a solution of this question can be found by analysing the effects of monochromatic light, from the X-rays to the infra-red, and by using other dyes for photosensitization. It is interesting that by variation of the time of exposure to the dye before irradiation with the same dose, or by varying the concentration of dye, mutation curves of a one-hit character are found. This suggests the interpretation that the adsorption of a single dye molecule by the genic substance of the cell causes a photosensitization, that is, the possibility that a light quantum absorbed in the dye molecule may be transmitted to a genetically active atom group that will be mutated by it. The fact of finding a typical optimum curve for the mutation- and killing-rates by varying the temperature of the dyeing process (optimum at 20° C.) suggests a permeability effect of the dye.

R. W. Kaplan

Erwin-Baur-Institut,
Voldagsen über Elze.
Oct. 4.

[1] Kaplan, R. W., *Z. Nat. Forsch.*, **3**, *b*, 29 (1948).
[2] Liechti, Feistmann and Gugenheim, *Strahlentherapie*, **64** (2), 353 (1939).
[3] Demerec and Latarjet, Cold Spring Harbor Symposium, **11**, 38 (1947).

Artificial Media for Rearing some Phytophagous Lepidoptera

Rearing insects on artificial or synthetic media has attracted the attention of numerous workers (cf. Trager[1]), because success would permit detailed investigation of nutritive requirements or would permit aseptic rearing of stocks for various medical or toxicological purposes. Methods hitherto employed have been most successful with larvæ such as dipterous maggots, which normally feed in a semi-fluid medium, or with cereal insects, which normally feed on a dry substrate. Difficulties have arisen when attempts were made to rear phytophagous insects, and, while some workers have reared older instars of such species on media, Bottger[2] seems to have been the first to carry a phytophagous insect, the European corn borer, through its entire feeding period on a purely artificial diet. Recent work in this Laboratory has led to the development of artificial media on which it has been possible to rear some phytophagous lepidopterous larvæ through all feeding instars. The method is reported here for use by interested workers in related fields.

A medium of satisfactory composition may be made by placing foliage in a Waring blendor and mixing it with a minimal amount of distilled water to produce a fine suspension. This is combined with agar to form a medium which is hardened in Petri plates or other suitable closed containers. Moulds and other contaminants grow on such a medium, for it cannot be sterilized without destroying its attractants, but the growths may be inhibited by the addition of appropriate fungicides. To date, sodium proprionate ('Mycoban') has proved to be the most satisfactory of these, for it does not counteract natural attractants, nor does it affect the growth or fecundity of the insects reared.

Most of the rearing tests have been made with larvæ of the spruce budworm, *Choristoneura fumiferana* (Clem.), on a medium of balsam fir (*Abies balsamea* Mill.) containing 100 parts of foliage suspension, 50 parts of 8 per cent agar, 1·5 parts of 10 per cent 'Mycoban' and 1·5 gm. of autolysed yeast. A detailed report of these tests will be published elsewhere, but it may be stated that groups of larvæ have been reared from the first feeding instar through the entire feeding period, and that both survival and fecundity per unit weight compare favourably with those of larvæ reared on ordinary foliage.

Two other species of lepidopterous larvæ, *Dioryctria reniculella* Grt. and *Archips rosaceana* Harr., have been reared successfully on the balsam medium, and *Archips fervidana* Clem. has been reared on a medium based on red oak (*Quercus rubra* Duroi). The success with all these insects is, in part, due to the fact that their natural feeding methods of needle-mining or web-spinning and leaf-rolling are easily carried over to the medium. On the other hand, some larvæ which are exposed feeders, such as the hemlock looper, *Lambdina fiscellaria* Gn., and the Neodiprionine sawflies, will not feed on the surface of an artificial medium. These larvæ clasp twigs while feeding, and it is impossible for them to behave in this way on the surface of the medium.

The advantages of rearing the four lepidopterous larvæ on simple types of artificial media are most conspicuous during the winter months. Thus, these initial successes point to the possibilities of rearing a wider variety of foliage feeders, particularly those which are restricted to deciduous leaves, at times when the food plants are not available, by 'deep-freezing' foliage-water suspensions and storing them at low temperature until required.

Eunice F. Wellington

Forest Insect Laboratory,
Sault Ste. Marie,
Ontario.
Sept. 22.

[1] Trager, W., *Biol. Rev.*, **22**, 148 (1947).
[2] Bottger, G. T., *J. Agric. Res.*, **65**, 493 (1942).

A Fungus Disease of Raspberries Induced by Insect Attack

The premature death of second-year raspberry canes believed to be due to cane blight disease (*Leptosphæria coniothyrium*) has often been observed to be related in severity to the attack on the first-year cane by larvæ of the raspberry cane midge, *Thomasiniana theobaldi* Barnes (Cecidomyidæ).

Following the early observations on the association of these two agents by Theobald[1] and Harris[2], the detailed work of Fox-Wilson and Green[3], while confirming this association, still left the question of primacy unsolved, as *L. coniothyrium* had been shown by Harris (unpublished work) to be exclusively a wound parasite, while Barnes[4] later showed that the midge was also dependent on a previous wounding before it could become established on the cane.

Observations by us during the past two years have shown that under field conditions the midge seeks and utilizes a variety of breaks in the epidermis of (first-year) canes for egg-laying purposes. The majority of such cover is provided by normal splits

in the rind of the cane, which occur commonly during the summer months. It has been determined that this normal splitting is more extensive in varieties showing higher susceptibility to midge attack.

The rind tends to peel back from these splits, and under it the colonies of larvæ become established and feed locally on the young periderm tissue for about fourteen days, causing the discoloration and death of small patches of cells averaging approximately 2 sq. cm. in area. When fully fed, the larvæ leave the cane to pupate in the soil, and a few weeks later fungal fructifications are commonly found on the damaged areas, but not on the surrounding healthy tissue. Tissue exposed by splits which have not been invaded by midge tends to harden and is not attacked by fungi. It would thus seem that the activities of the midge produce a substrate favourable for the establishment of fungal wound parasites.

It is now known that in addition to *L. coniothyrium*, a species of *Fusarium culmorum* and *Didymella applanata* (the cause of spur blight in raspberries) similarly enter the cane through midge-feeding lesions, causing severe damage. These two additional fungi are found more commonly than *L. coniothyrium* during the summer months.

Tests so far carried out suggest that the midge does not introduce fungal spores into the splits, but rather that they are air- or water-borne.

One of us (R. S. P.) wishes to make acknowledgment to the Agricultural Research Council, which has financed the entomological side of this investigation.

R. S. Pitcher
P. C. R. Webb

East Malling Research Station,
Nr. Maidstone, Kent.
Oct. 12.

[1] Theobald, F. V., Min. of Agric. Monthly Summaries of Insect Pests of Crops for 1921 (not published).
[2] Harris, R. V., Rept. E. Malling Res. Stat. for 1929, 68 (1930).
[3] Fox-Wilson, G., and Green, D. E., *J. Roy. Hort. Soc.*, **69**, 79 (1944).
[4] Barnes, H. F., *J. Roy. Hort. Soc.*, **69**, 370 (1944).

Biological Oxidation of Manganous Sulphate in Soils

F. C. Gerretsen[1] demonstrated the biological oxidation of manganous sulphate in soils. G. W. Leeper and R. J. Swaby[2] confirmed this. A preliminary report is made here of investigations carried out to find the micro-organisms involved in the process.

Gerretsen isolated what he termed manganese-oxidizing bacteria on a mineral-salts medium containing calcium citrate and manganous sulphate. We have isolated on this medium a few organisms which oxidize the manganese. Those identified belong to the genera *Pseudomonas*, *Serratia* and *Aerobacter*. None of these organisms when added alone to a sterile soil of *p*H 6·8 will reproduce the manganese oxide rings described by Leeper and Swaby[2]; mixtures of these organisms will not.

Gerretsen's medium was discarded, and a medium prepared from a soil of *p*H 6·8 which exhibits manganese deficiency for plants was used. The medium was prepared by shaking a 1/20 mixture of the soil and water and decanting the suspended material. To this suspension, agar and hydrated manganous sulphate were added to give final concentrations of 2 and 0·005 per cent respectively. The medium was autoclaved at 15 lb. for 20 min. on three consecutive days.

Material sown from the oxide ring[2] to this medium showed oxidation of the manganese in the confluent growth, but no single colonies taken from these plates could oxidize manganese. Pure cultures of single colonies were isolated and then mixed in pairs. Certain pairs could oxidize the manganese in this medium. These pairs, when inoculated into sterile soil agar (*p*H 6·8), reproduced the type of oxide rings found with the unsterilized soil; singly, the cultures did not. The pairs will oxidize the manganese in filtered water soil extracts plus 0·005 per cent manganous sulphates in 48 hours. The oxidation occurred at a *p*H below 7·0 in this extract.

The investigation is proceeding along two lines. One is the study of the process by which the paired bacteria oxidize the manganese. The other is to determine the significance of these organisms in rendering manganese unavailable to plants.

The possibility of the existence of other micro-organisms involved in the oxidation of manganese has not been overlooked.

V. B. D. Skerman
S. M. Bromfield

School of Bacteriology,
University of Melbourne,
Melbourne, N.3.

[1] Gerretsen, F. C., *Verslag Landbouwk Onderzoek*, No. 42 A, 57 (1936).
[2] Leeper, G. W., and Swaby, R. J., *Soil Science*, **49**, No. 3, 163 (1940)

A Narwhal in the Thames Estuary

The recent stranding of a narwhal (*Monodon monoceros*) at Rainham, Essex, is a record of considerable interest. This species is usually limited to Arctic waters, although it occasionally penetrates into the North Sea. The infrequency of its occurrence off the British coast may be gauged by the fact that since 1588, when one was found on the coast of Norfolk, as recorded by Purchas[1], only three other instances until the present one are known. These were one on the Isle of May in the Firth of Forth, in June 1648; one near Boston, Lincolnshire, in February 1800; and one in the Sound of Weesdale, Shetland, in September 1808.

The Rainham animal, which stranded on February 17, 1949, was a female 12 ft. 11 in. in length. It was photographed several times after having been hoisted into the air by a riverside crane, and the pictures of it make identification of species certain: the general body-form, mottled pigmentation, characteristic shape of the flippers and tail flukes, and the absence of a dorsal fin all point to the animal having been a narwhal. There was no tusk projecting from the snout such as is found in the male.

Unfortunately, first information about the Rainham narwhal was not obtained until it was too late to inspect the carcase; it sank while being towed from the place where it first stranded.

F. C. Fraser

Department of Zoology,
British Museum (Natural History),
London, S.W.7.

[1] "Purchas his Pilgrimage", 621 (London, 1613).

SUB-MICROSCOPIC LOCALIZATION OF MINERALS IN SKELETAL MUSCLE BY INTERNAL 'MICRO-INCINERATION' WITHIN THE ELECTRON MICROSCOPE

By Dr. M. H. DRAPER*
Physiology Department, University of Adelaide
AND
A. J. HODGE
Division of Industrial Chemistry, Council for Scientific and Industrial Research, Melbourne

RECENT work on contractile phenomena in muscle[1] indicates that a complete understanding of these processes demands a fuller knowledge of the sub-microscopic morphology and distribution of the mineral content. An electron microscopic study of muscle has therefore been undertaken as part of a general investigation of fibrous proteins[2] in progress in this laboratory. The present communication represents a part of the investigation which should be of immediate interest to workers in this field.

The morphology of skeletal muscle has been described within the limits of optical resolution by numerous workers[3]. The main structural features and the 'reversal of striation' phenomenon, which gives rise to contraction bands, have been confirmed by recent electron microscopical studies[4]. Knowledge of the distribution of mineral content has been derived from staining and micro-incineration techniques[5], and more recently by the application of the emission electron microscope[6], whereby it is possible to differentiate potassium and sodium from calcium and magnesium. However, the limited resolving power available from these methods did not allow precise location of the mineral content on a sub-microscopic scale. The method described here has enabled us to locate inorganic matter with a precision of approximately 100 A.

In applying the new technique, we have employed suspensions of myofibrils obtained from formalin-fixed toad and rabbit leg muscles, which are structurally very similar. The term 'myofibril' as used here refers to fragments of tissue rather than the intact myofibril of the classical morphologist. Fig. 1 is an electron micrograph of a myofibril stained with phosphomolybdic acid, which effectively increases the over-all contrast and enhances certain features of the myofibrils. In the examination of muscle we have found this reagent more suitable then phosphotungstic acid, which tends to 'stain' the myofibrils too deeply owing to the higher electron-scattering power of tungsten atoms. The *Z*, *M*, *Q* (or *A*), *H*, *J* (or *I*) and *N* bands are clearly visible, as are the four fine bands lying, two on either side of and adjacent to the *M* band, within the *H* band. The latter fine bands have not previously been described and their significance is unknown. We have found, in agreement with the work of Hall, Jakus and Schmitt[4], that the myofibrils contain longitudinal filaments, presumably of actomyosin, which are aligned parallel and extend continuously through all bands in both the extended and contracted states. There is some evidence to suggest that the myofibrils are thin sheets of this fibrous material, which in the intact muscle are folded about the long axis and embedded in bundles of collagen protofibrils. This thesis affords an explanation of the irregular shapes and variable sizes of myofibrils as seen in transverse section. Another morphological feature visible in Fig. 1 is the periodic darkly staining transverse striation which appears throughout the length of the sarcomere. The spacing is about 400 A. and varies inversely with the degree of contraction within the limits of error arising from fortuitous stretching of contracted myofibrils during preparation of the suspensions. Fig. 2 shows unstained myofibrils which have been shadow-cast with platinum. The fine periodic striation is particularly evident, and it is to be noted that it is a feature of the individual actomyosin filaments. The thinness of the material is evident from the small shadow-length.

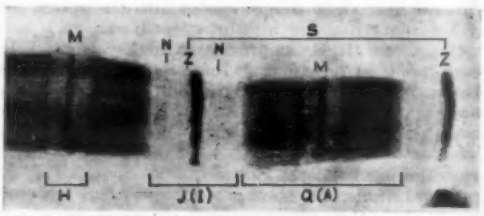


Fig. 1. Myofibril from formalin-fixed toad skeletal muscle, stained with phosphomolybdic acid. 20,000× Positive print (that is, enlarged from original plate as negative)

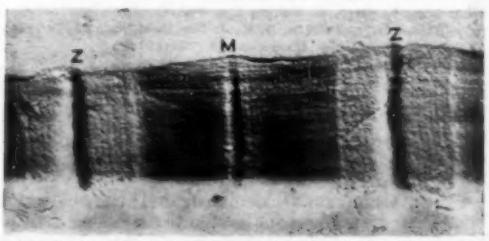


Fig. 2. Myofibril from formalin-fixed toad skeletal muscle, shadow-cast with 10 A. thickness of platinum; shadow ratio approximately 4 : 1; printed with shadows white. 20,000× Positive print

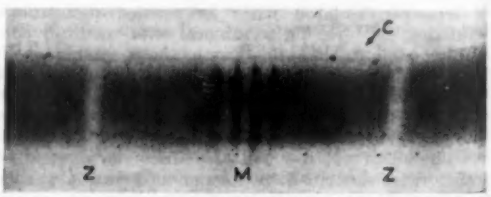


Fig. 3. Myofibril from formalin-fixed rabbit skeletal muscle after exposure to high-intensity electron beam in the electron microscope. 20,000× Positive print

S, sarcomere
Q (*A*), *Q* band or anisotropic band
J (*I*), *J* band or isotropic band
Z, *Z* band or telophragma
M, *M* band or mesophragma
H, *H* band
N, *N* band
C, collagen protofibril

* Junior Research Fellow, National Health and Medical Research Council.

The success of the 'micro-incineration' technique depends on the ability to attain high current densities through the specimen, a condition which was easily satisfied by the use of a cathode-biased electron gun on our R.C.A. Model *EMU* electron microscope. It was observed that unstained myofibrils, when suddenly subjected to a high-intensity beam in the electron microscope, suffered a serious decrease in contrast, presumably resulting from the loss of bound water, organic matter and salts volatile under electron bombardment. The recent observation[6] that the evaporation of potassium salts under high-intensity beams in the electron microscope may not be an entirely thermal phenomenon has led us to believe that our observation was of an essentially similar nature. However, in a few fields containing myofibrils of favourable dimensions, the structure of the residue was particularly clear. Fig. 3 is an electron micrograph of such a field. A striking feature of the phenomenon is the complete disappearance of *Z* and *M* bands. This has been observed to occur in a large number of myofibrils. However, the fine transverse striation was only obtained when the optimum conditions of myofibril dimension and rate of increase of beam intensity were satisfied. The periodicity of these bands of residual crystalline material was again about 400 A., leaving little doubt that they correspond with the striations present in both stained and unstained myofibrils viewed with low beam-intensity (Figs. 1 and 2). The relatively refractory nature of the residual crystalline material suggests that it consists almost entirely of salts of magnesium and calcium, a finding which is supported by the thermal stability and relative resistance to electron bombardment exhibited by crystals of these salts. The ease with which potassium salts may be evaporated under similar conditions justifies the conclusion that all the potassium content of the myofibrils was evaporated under the influence of the beam.

Since we have invariably used suspensions of the fixed material obtained by mechanical agitation and afterwards centrifuged and resuspended several times in distilled water, it must be concluded that the residual mineral content of the myofibrils is either bound by the protein or present in the form of insoluble salts. The disappearance of the *Z* and *M* bands and of the *Q* substance during 'micro-incineration' (Fig. 3) indicates that magnesium and calcium are either absent, or present only in very small amount in these components. Furthermore, their content is distributed periodically throughout the sarcomere.

The distribution of potassium is less definite than that of magnesium and calcium. Macallum[7] obtained a distribution of potassium resembling the distribution of density in Fig. 1. The distribution of mineral ash as demonstrated by Scott[8] was similar, the *J* and *H* bands being almost ash-free, while the *Q* and *Z* bands were represented by deposits of ash. It is to be noted that the thickness variation of the dehydrated myofibrillar fragments, as evident from the shadow in Fig. 2, corresponds exactly with this ash distribution. Preliminary experiments have shown that the myofibrils in our suspensions contain some potassium, amounting to about 0·05 per cent of the dry weight, and apparently firmly bound by the protein. The disappearance of the *Z* and *M* bands and of the *Q* substance during high-intensity electron bombardment then suggests that the mineral content of these components consists largely of potassium and perhaps sodium.

This conclusion is interesting when compared with the affinities for phosphotungstic acid exhibited by the various bands. Although this reagent is used in the analytical determination of potassium[9], it is known to react with proteins and protamines, and cannot be regarded as specific for the localization of potassium. However, the low affinity of the *J* and *H* bands and the high affinity of the *Z*, *M* and *Q* bands for this reagent indicates that at least a part of its 'staining' action on muscle is attributable to combination with potassium held by the protein.

With these observations in mind, the ultrastructure of skeletal muscle begins to assume a concrete form. The myofibril consists of long filaments of actomyosin, aligned parallel in thin sheets, the filaments being held together by the transverse *Z*, *M* and lesser bands and perhaps also by an interfilamentous matrix substance. A regular fine transverse striation is present arising from a periodic concentration of magnesium and calcium bound to the actomyosin framework, the periodicity being about 400 A. Superimposed on this skeletal framework is the *Q*-substance, which presumably contains protein in globular form, potassium, chloride, phosphate, adenosine triphosphate and other constituents, and which moves in characteristic fashion within the sarcomere during contraction. While it is clear that *Z* and *M* bands exercise a structural function in binding the filaments together, it seems likely that they perform other functions also, possibly connected with innervation of the myofibrils.

The new technique has also been successfully applied in the determination of mineral distribution in collagen protofibrils, one of which may be discerned in Fig. 3. The minute residue is concentrated in the narrow portions of the collagen repeating-units.

Further work is proceeding on the localization of mineral content of muscle, collagen and other fibrous protein tissues. A fuller account will be published elsewhere.

[1] Szent-Györgyi, A., "Chemistry of Muscular Contraction" (New York, Academic Press, 1947).
[2] Farrant, J. L., Mercer, E. H., and Rees, A. L. G., *Nature*, **159**, 535 (1947).
[3] Jordan, H. E., *Physiol. Rev.*, **13**, 301 (1933).
[4] Hall, C. E., Jakus, M. A., and Schmitt, F. O., *Biol. Bull.*, **90**, 32 (1946).
[5] Scott, G. H., and Packer, D. M., *Anat. Rec.*, **74**, 31 (1939).
[6] Burton, E. F., Sennett, R. S., and Ellis, S. G., *Nature*, **160**, 565 (1947).
[7] Macallum, A. B., *J. Physiol.*, **32**, 98 (1905).
[8] Scott, G. H., *Proc. Soc. Exp. Biol. Med.*, **29**, 349 (1932).
[9] Rieben, W. K., and van Slyke, D. D., *J. Biol. Chem.*, **156**, 765 (1944).

THE TEACHING OF BIOLOGY IN SCHOOLS

TWO "Educational Papers" have recently been published by the British Social Hygiene Council. No. 1 deals with "Biology in the Secondary Modern School", by Frank Tyrer, while No. 2 is concerned with "Social Biology for Sixth Forms", by Eric Lucas. Presumably, coming from such a source, they may be looked upon as propaganda or, more correctly, information of use to those who sympathize with the ideals of the British Social Hygiene Council, and, in this case, are actively concerned with the spread of those ideals, for they are both pamphlets of primary use to teachers. Presumably again, they must have been passed by an editorial board or at

least an editor. But what is most puzzling is how two such completely diverse pamphlets could have been approved by the same editor, for, if either one points the good way to teaching the subject then, without any shadow of doubt, the other points in the opposite direction.

The first pamphlet deals in a simple straightforward way with the teaching of biology to pupils during their four years at a secondary modern school. The ground covered by the syllabus is admirable—perhaps this is because there is no particular examination at the end; but in any event it is conceived in a fundamentally sound manner, the object in view being on one hand to give the child a simple idea of how its own body works and on the other to demonstrate its relation to the society in which it lives. Moreover, it deals in a straightforward way with the idea of evolution so that the child comes to realize that this conception is no private concern of biology, but refers to all things which he sees around him. From the practical point of view it rightly insists on building the course on the elementary nature study which it assumes has been done at the elementary school. At the other end it points out how much valuable work can be done by arranging for the children to visit outside institutions—hospitals, sanitary works, factories and so on—to see how the knowledge of biology is applied in the social services. One small point of criticism which is probably due to an oversight on the part of the author is that there is no mention of the use of museums at this stage of education. Museums, properly used, can be of great value to modern school children, especially in cities where it is difficult for children to get out into the country to study some natural history problem at first hand. The study of one particular group of animals or plants can be used as a tree on which to hang all sorts of valuable ideas; thus in the last year in the modern school, the child might take up such a group as fishes or spiders or so on, and here the museum, preferably with a sympathetic curator, can be of very real value. The pamphlet throughout is well planned: the author does not over-emphasize any particular aspect. He clearly has no particular axe to grind, and he knows how to teach.

The second pamphlet, on the other hand, can only be described as fantastic. It purports to deal with the way in which biology, and social biology at that, can be introduced to a sixth form who have done no biology before—"a mixed class of history, classics and mathematics specialists is perhaps the most desirable". The time allowance is two 45-minute periods per week for one whole year. The published syllabus *for the first term alone*, ignoring its more absurd extravagances, contains the fundamental introduction to animal biology, let alone its references to botany, that a professor of zoology would hesitate to deal with in under a complete year, and at the university a professor can reckon on at least three one-hour periods per week backed up by six hours practical work in which the student can clear up his ideas by 'picking the brains' of the demonstrators. The second term's work is devoted very largely to a study of Mendelism, or to be fashionable perhaps we had better call it Neo-Mendelism. The third term continues with even more Mendelism and then goes on to a general consideration of psychology, even including *Gestalt* psychology, and after trifling with such things as intelligence tests and the diagnosis of mental deficiency, is rounded off with a discussion of the validity of psychology and the question of the free will!

Looking at the course as a whole, what strikes one immediately is the over-emphasis which is placed on the study of Mendelian inheritance; but this misguided tendency is nothing new. A glib knowledge of Mendelism is the one thing we can rely on among university scholarship hunters, however ignorant they may be on other matters. It is difficult to see what school teachers find of general educative value in this elaborate study of one particular type of inheritance. It is easy to teach, that is certain; but one hesitates to suggest that this is the reason why such a large proportion of the course is devoted to it.

As regards the detailed items of this syllabus, some are incredible. For example, after suggesting that the course should be introduced by a discussion on "the general characteristics of living matter, assimilation, respiration, irritability, reproduction and so on", which is all right so long as one spends sufficient time over it, it is necessary to point out the difference between animals and plants, and for this purpose, *mirabile dictu*, a discussion of plankton 'indicators' in relation to the herring industry is called for! This, so far as can be assumed from the syllabus, would occur at about the second lesson of the course, and it must be borne in mind it is designed for boys who have done no biology before. However, the cavalier way in which these difficulties of teaching are dealt with can be seen in such sweeping suggestions as "the study of the physiology of the sense organs, nerves, brain and spinal cord . . . dealing particularly in aspects that have philosophical implications". Apparently the philosophical side must be dealt with (whatever this means); but there is no evidence that any time is to be wasted on the *anatomy* of the organs. And then, further on, "Reproductive systems, fertilisation and embryology are described . . . and a simple account of experimental work on amphibian and chick embryos leading to the discovery of organisers is given"—an admirably conceived idea; but I wonder how long the author of this pamphlet takes to demonstrate to these sixth-form pupils the difference between a gastrula of a frog and the blastoderm of a chick.

The clue to this extraordinary pamphlet is probably to be found in the introduction, where it states that it is absolutely essential to be able to pursue at length any particular part of the course with discussions and debate in class; but equally "if the subject seems to be too difficult to hold the interest . . . the teacher must feel free to drop it". The very idea that if a teacher finds a part of the course boring or if his students find it boring then they should drop it and go on to something else is surely something new. An elementary biology course, as T. H. Huxley pointed out, is or should be a continuous whole. It may be possible to teach other elementary subjects by snippets here and snippets there; but this certainly does not apply to biology. What is this type of teaching leading to? It caters for just that type of 'talky-talky' which is becoming so fashionable nowadays under the heading of general knowledge to be given as (at present) a non-examinable subject to sixth forms. It is just the sort of thing for that type of student, so common among scholarship candidates, who can write glibly about any subject under the sun without any real understanding of the subject-matter. So long as this sort of general knowledge is kept, as at present, simply as something to occupy the spare time of the sixth-form

pupils outside their specialized subjects and to stimulate them to think, then little harm can be done by the syllabus. But if, as seems likely, this general knowledge is to be included in the new examination as an examination subject, then the syllabus should be condemned outright. Its use would merely intensify the deplorable tendency, which those of us concerned with scholarships and the Higher School Certificate know only too well, of learning whole passages and whole problems by heart on the chance of getting a question on them in the examination. To suggest that there are boys who, not knowing any biology before, could really assimilate in approximately eighty 45-minute periods the contents of this syllabus and retain a coherent idea of its range is asking too much of the imagination.

H. GRAHAM CANNON

STRUCTURE OF THE RESTING NUCLEUS IN *MARASMIUS ANDROSACEUS* FRIES.

By DR. J. A. MACDONALD
University of St. Andrews

HOLLANDE[1] considered that living protoplasm in general consisted of filamentous, hyaline tubes with numerous clusters, made up of two punctiform corpuscles, distributed over their surface; and that the nucleus had a comparable structure. Hollande and Hollande[2] made similar findings for Bacteria and Cyanophyceæ. Drennan[3], studying human blood, described granules which moved freely in the serum and which were of different kinds, as they reacted differently to stains and varied in size and degree of motility. Sparrow and Hammond[4] noted Feulgen-positive bodies in the cytoplasm of the meiotic prophase stages of microsporocytes in eleven different flowering plants. These bodies appeared to originate in the nucleus or at the nuclear membrane. They regarded the positive Feulgen reaction together with high absorption at 2537 A. and 2650 A. as proof that the bodies contained desoxyribose nucleic acid, and strong absorption at 2804 A. as an indication that protein also was present. Calvet, Siegel and Stern[5], as a result of electron optical observations, reported that the resting nuclei of calf thymus lymphocytes, treated with lanthanum acetate, showed nucleoprotein ultrafibrils of approximate thickness 80–100 A. These appeared banded. They concluded that the banded appearance was probably due to the coiling of a fine thread to form long helices and that the spirals might be formed by individual desoxyribonucleoprotein molecules in combination with lanthanum ions. Malvesin-Fabre[6] found, in the living nuclei of *Arum italicum*, that there were chromocentres which continuously changed their form and appearance and that the nucleus showed continuous activity in the resting stage. Ritchie[7], working on fixed and stained basidia of *Amanita cæsaria*, found extra-nuclear inclusions, frequently near the base of the basidium, which were readily stained with hæmatoxylin and were Feulgen-positive. He regarded them as chromatic in nature.

The recent papers cited above show that there is an accumulating body of evidence which points to the existence in the cells of many plant and animal groups of: (1) chromatic bodies in the cytoplasm; (2) a fibrillar structure for the protoplasm; (3) a high degree of activity associated with the so-called resting nucleus.

In an account given to Section K at the recent meeting of the British Association at Brighton, I described observations made on the mycelia of *Marasmius androsaceus* Fries. and put forward a theory on the structure of the resting nucleus in this basidiomycete. Many of the general points raised are referred to in a paper to be published elsewhere[8]. In view of the evidence referred to above, it seems desirable to put on record the principal points in my account which refer to nuclear structure.

Growing hyphæ were studied with the use of agar films supported on coverslips[9], using phase-contrast methods. Apparatus of the type recommended by Burch and Stock[10] was used in this laboratory, pending the arrival of the outfit manufactured by Cooke, Troughton and Simms; but observations have been checked on the latter type of instrument at the Strangeways Laboratory, Cambridge, through the courtesy of the director, Dr. Fell, and of Dr. Hughes. Fixed and stained preparations have also been made using half-strength Flemming's fluid[11] and a number of non-osmic fixatives[12,13], of which Belling's modification of Navashin has been the most successful. Heidenhain's hæmatoxylin[11] and the Feulgen stain have been used; the former counterstained with Light Green[11] and the latter with Fast Green[14] when desirable.

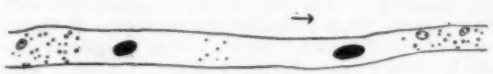


Fig. 1

The living hyphæ contain paired, grey structures, round or oval in outline, corresponding in size and position with the heterokaryotic pairs of nuclei so often seen and figured in stained preparations of basidiomycete mycelium. In addition, there are numerous moving dark granules scattered throughout the cytoplasm. There is an area of marked concentration of these granules nearer the hyphal tip than the more advanced member of the pair of grey bodies and a similar area behind that which is farther away from the tip. Between the two grey bodies there is also a region of concentration of granules, though this is less pronounced than the first two. Some of the granules are associated with cleared areas in the cytoplasm and are paired (Fig. 1). They may move relative to each other, but their association is maintained. In the Basidiomycetæ generally, clamp-connexion formation is associated with the division of the two nuclei of the heterokaryon. In *Marasmius androsaceus* Fr., as a clamp connexion begins to form, the two grey bodies position themselves so that one is in the developing hook of the clamp connexion and the other at or near it in the parent hypha. The cytoplasmic activity in general and that of the granules in particular becomes concentrated very near or on the grey bodies (Fig. 2).

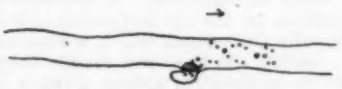


Fig. 2

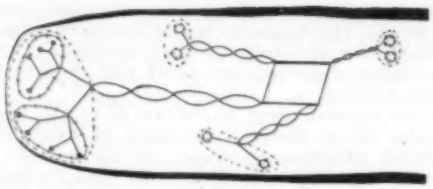


Fig. 3

The latter then divide in two, and cross-walls are laid down in parent hypha and clamp connexion. Spindles have not been seen in living material. A study of fixed preparations stained with : (*a*) hæmatoxylin or (*b*) Feulgen stain showed : (*a*) (1) when the grey bodies are not near the clamp connexions, that is, are not approaching or in process of division, they do not stain deeply and can be distinguished clearly from the general cytoplasm only if Light Green is used as a counterstain. Paired granules staining deeply with hæmatoxylin are to be seen in the cytoplasm. Sparrow and Hammond[4] comment on the frequency of cells showing a correlation between lightly stained nuclei and a large volume of cytoplasmic bodies (Feulgen reaction). (2) When the grey bodies are near clamp connexions which are forming, they stain darkly. They may have a mottled appearance, suggesting that granules are present on their surface. Deeply stained granules are no longer visible in the cyto- asm. (*b*) (1) The grey bodies are Feulgen-negative and there are pairs of Feulgen-positive granules in the cytoplasm. The grey bodies counter-stain with Fast Green. This indicates the nucleolus in higher plants[14]. (2) Near the time of division, the grey bodies are in part Feulgen-positive, in part stainable with Fast Green. The Feulgen-positive granules are missing from the cytoplasm.

The above observations show that, if the conventional idea of the resting nucleus is accepted, there is extra-nuclear chromatin present in the vegetative cells of *Marasmius androsaceus* Fr. The fact that the Feulgen-positive cytoplasmic granules are often paired is regarded as evidence in favour of the theory that they represent either the two complete chromatids, or equivalent aggregates of chromatin-containing material from the two chromatids of a chromosome, loosely attached together. The fact that these Feulgen-positive granules are widely distributed in the cytoplasm, yet are drawn towards and finally become closely associated with the Feulgen-negative grey body, at the time of nuclear division, is believed to be strong evidence in favour of a theory that the nucleus in the 'resting' condition consists of a Feulgen-negative shadow nucleus to which the chromosomes or parts thereof are attached by means of threads of variable length, composed of protein molecules (possibly polypeptide in nature). The extensible or retractable nature of the protein chain visualized is such that it would make it possible for the active material in any chromosome to be carried to that part of the cell where its activity is required at any given time. Thus the laying down of new wall material, in the terminal 10–20 μ of the hypha to which growth is confined, would be carried out by the activity of a pair of granules in the tip and remotely controlled only by the shadow nucleus which is situated about 120 μ from the tip and thus well outside the growing region. At the approach of nuclear division, shortening of the molecule chains, by bringing granules and shadow nucleus together, would produce the stainable nuclear entity usually depicted in association with clamp connexions. Fig. 3 is a theoretical diagram illustrating the organisation of a resting nucleus with four chromosomes.

It is hoped that the existence of the molecular chains may be susceptible of proof with the electron microscope, and some preliminary investigations have been carried out on this problem.

[1] Hollande, A. C., *Arch. Zool. Exp. et Gén.*, **83** (Suppl.), 269 (1943).
[2] Hollande, A. C., and Hollande, G., *Arch. Zool. Exp. et Gén.*, **84** (9), 375 (1944).
[3] Drennan, M. R., *Clin. Proc.*, **3** (4), 171 (1944).
[4] Sparrow, A. H., and Hammond, M. R., *Amer. J. Bot.*, **34** (8), 439 (1947).
[5] Calvet, F., Siegel, B. M., and Stern, K. G., *Nature*, **162**, 305 (1948).
[6] Malvesin-Fabre, G., *C.R. Soc. Biol.*, **135**, 590 (1941).
[7] Ritchie, D., *Bot. Gaz.*, **109**, 521 (1948).
[8] Macdonald, J. A., *Proc. Roy. Soc. Edin.* (B) (In the press).
[9] Macdonald, J. A., *Trans. Brit. Mycol. Soc.*, **31**, 92 (1947).
[10] Burch, C. R., and Stock, J. P. P., *J. Sci. Instr.*, **19** (5), 71 (1942).
[11] Gwynne Vaughan, H. C. I., and Barnes, B., "Structure and Development of the Fungi" (1937).
[12] La Cour, L., *Bot. Rev.*, **3**, 241 (1937).
[13] La Cour, L., *Bot. Rev.*, **13**, 216 (1947).
[14] Hillary, B. B., *Bot. Gaz.*, **102**, 225 (1941).

A NOTATION FOR THE LEWIS AND LUTHERAN BLOOD-GROUP SYSTEMS

BY means of a grant from the World Health Organisation, the following were able to meet to discuss a notation for the Lewis and Lutheran blood-group system: P. H. Andresen, Universitetets Retsmediciniske Institut, Copenhagen; S. T. Callender, the Radcliffe Infirmary, Oxford; R. A. Fisher, Department of Genetics, Cambridge; R. Grubb, Bakteriologiska Institutionen, Lund; W. T. J. Morgan, Biochemical Department, Lister Institute, London; A. E. Mourant, Ministry of Health, Lister Institute, London; M. M. Pickles, Pathological Department, Radcliffe Infirmary, Oxford; R. R. Race, Medical Research Council, Lister Institute, London. The appended report has been prepared.

"For both the Lutheran[1] and Lewis[2] blood-group systems the symbols L_1 and L_2 have been used[3,4]. The Lewis system is being actively investigated at the present time, and the need for distinctive symbols has become urgent.

In agreeing to use the following notation we are adhering, so far as the genes and genotypes are concerned, to present usage in plant and animal genetics. In human genetics there is as yet no systematized genetical notation in use, though Ford has suggested such a notation for the A_1 A_2 B O blood groups[5]. The notations we have chosen conform with that of Ford.

System	Lewis	Lutheran
Genes	*Le*	*Lu*^{a}
	Le^b	*Lu*^{b}
Genotypes	*Le*^{a}*Le*^{a}	*Lu*^{a}*Lu*^{a}
	Le^a*Le*^{b}	*Lu*^{a}*Lu*^{b}
	Le^b*Le*^{b}	*Lu*^{b}*Lu*^{b}
Phenotypes	*Le*^{a}($a+b-$)	*Lu*^{a}($a+$)
	Le^a($a-b+$)	*Lu*^{a}($a-$)
	Le^a($a-b-$)	
Antibodies	anti-*Le*^{a}	anti-*Lu*^{a}
	anti-*Le*^{b}	

No distinction is made between the symbols for the genes and those for the antigens.

The antibody anti-Le^a corresponds to the original[2,5] anti-Lewis and to the anti-L_1 of Andresen[4]; and anti-Le^b to Andresen's anti-L_2.

If only one antiserum, anti-Le^a, is used the phenotypes which it defines are called $Le(a+)$ and $Le(a-)$.

In the *Lu* system anti-Lu^a corresponds to the original anti-Lutheran of Callender and Race[7]. The phenotype $Lu(a+)$ thus includes both the phenotypes L_1 and L_2 of Mainwaring and Pickles[3].

These notations can readily be expanded to allow for future developments. For example, in the *Le* system the known phenotype $Le(a-b-)$ might be shown to be due to a qualitatively different third allele which would be written Le^c. In the *Lu* system the quantitatively differing L_1 and L_2 might become Lu^{a_1} and Lu^{a_2}.

The duplication of the *Ss* notation with reference to salivary secretion of blood-group substances on one hand and to subgroups of the *MN* system on the other has been considered, in view of the close connexion of secretion with the *Le* system[7,8,9]. Since this duplication has not so far caused confusion, it has been decided not to recommend any changes in the use of *S* and *s* pending further work on the *Le* system."

[1] Callender, Race and Paykoç, *Brit. Med. J.*, ii, 83 (1945). Callender and Race, *Ann. Eugen., Camb.*, **13**, 102 (1946).
[2] Mourant, *Nature*, **158**, 237 (1946).
[3] Mainwaring and Pickles, *J. Clin. Path.*, **1**, 292 (1948).
[4] Andresen, *Acta Path. Microbiol. Scand.*, **25**, 728 (1948).
[5] Andresen, *Acta Path. Microbiol. Scand.*, **24**, 616 (1947).
[6] Ford, "Genetics for Medical Students" (London, 1942).
[7] Grubb, *Nature*, **162**, 933 (1948).
[8] Grubb and Morgan, *Brit. J. Exp. Path.* (in the press).
[9] Race, Sanger, Lawler and Bertinshaw, *Brit. J. Exp. Path.* (in the press).

THE TEACHING OF PHYSICS

THE second conference on the teaching of physics, organised jointly by the Institute of Physics and the Ministry of Education, was held at the Institute of Physics, 47 Belgrave Square, London, S.W.1, during February 24–26. Dr. F. C. Toy, president of the Institute, in welcoming the members and opening the conference, spoke of the need for producing a broad and cultured outlook, which should develop men who were both good physicists and good citizens.

At the first session, Dr. B. P. Dudding and Mr. C. E. Beynon opened a discussion on "Physics for Part-time Students from Industry". Dr. Dudding said that the present close relations between engineering and physics require that engineers should be trained in the application of scientific method, by courses which present a broad outline of the subject without too much academic detail. Technical ability is less important than personal qualities of judgment and character, and the ability to analyse problems as they arose. It is only too easy to read one's own convictions into the interpretation of data, and the teaching of basic physics should be done in such a way as to cultivate intellectual honesty.

Mr. Beynon spoke of the need, greater now than in the time between the two World Wars, for more highly trained men in the higher ranks of industry, and suggested that if the present methods of recruitment are unsuitable, better means must be found. The technical colleges of the future should make pure and applied physics major subjects in their courses, training students by doing rather than mere learning, and cultivating a practical as opposed to an abstract academic view of these subjects. Part-time students from industry would work beside full-time students from the universities, and while meeting the needs of both, the technical colleges should develop an individuality of their own, not modelled on either the universities or apprentice schools. Details of a course of training were outlined, and Mr. Beynon suggested that the satisfactory completion of such a course should be recognized by some kind of award which would have a 'hard currency' value in industry.

At the evening session, Mr. C. W. Robson opened a discussion on "National Certificates in Applied Physics". These certificates, of two grades, ordinary and higher, were first awarded in 1947, and are intended to provide training for, and a regular means of entry into, the profession of 'engineer-physicist' as an alternative to the conventional academic route. A helpful introduction to this discussion had been provided by the assistant secretary of the Institute of Physics, Mr. N. Clarke, who had circulated to members of the conference copies of his paper on the Institute's educational activities[1], in which the present position is described. Mr. Robson outlined the courses and syllabus followed at the South-East London Technical College, where at present 118 day and 66 evening students are preparing for the Ordinary Certificate. Points raised in the discussion were: the difficulty of organising such courses in smaller technical colleges remote from any large industrial centre, the problem of examination standards, and the unsatisfactory nature of the conventional type of practical examination.

On the second day, with Dr. H. Lowery in the chair, Dr. G. van Praagh gave a paper on the "Teaching of Physics in Secondary Schools", and described the equipment and curriculum at Christ's Hospital, giving some details of the teaching carried on under almost ideal conditions in the appropriately named "Science Workshops" there. Sir Graham Savage opened the discussion by remarking on the importance of training the young to use their hands and their powers of observation, and also said that valuable contributions to the teaching of the subject could be made by men of enthusiasm who were not primarily qualified as physics specialists. Most of the schoolmasters present contributed accounts of their own methods of selecting material or adapting its presentation in such a way as to develop the pupils' enterprise and judgment. The discussion centred around the spirit in which the subject should be approached. Some speakers considered that examination syllabuses might well be pruned; but little was said on the almost exhausted topic of examinations themselves.

Wing-Commander R. E. Burnett, of the Ministry of Labour, speaking on "Careers in Physics", said that while only the high-honours graduate should contemplate a research career, there was a need for many men with other gifts on the purely technical side of industry, and employers should be educated not to demand high academic qualifications for jobs where they are not essential. About eight hundred physics graduates are required annually, half of them for teaching, and at present some seven hundred are being trained. There is a very great shortage at present of people interested in 'classical' physics.

Mr. F. Bray (Under-Secretary, Ministry of Education) took the chair for the third day's session.

Mr. F. Y. Poynton spoke on "Applied Physics in Technical Colleges", and described the work done in the formal courses at the Northampton Polytechnic, and also in special courses of lectures and practical work which had been established from time to time to meet some particular need, instancing the course on high-vacuum work in his department, which many members of the conference had been able to visit. Dr. J. Topping, in a paper on "Research in Technical Colleges", emphasized the importance of research as a vitalizing factor in the work of a college, and mentioned the difficulties that arose in the implementation of Circular 94. At the Regent Street Polytechnic only a few of the many applicants for part-time research could at present be accepted, and the demand for higher study is being to some extent met by postgraduate lecture courses instead. The interests and ability of the staff will determine the type of research undertaken in a particular college; the problems will usually be such as require only limited space and equipment, and will be linked with the specialist courses in applied physics. It has to be considered how far the suggestion of the Percy Committee, that colleges should undertake investigations for local industrial firms, is practicable or desirable. During the discussion, Dr. J. E. Richardson said that there must be a distinction between the problems posed by industry and those selected by the colleges themselves. The first line of attack is for the colleges to choose work which will be of industrial significance. Dr. Lowery suggested that the technical colleges will only attain their full status when industry, and the governing bodies of the colleges themselves, have been brought to appreciate that they are really capable of carrying out major research of a high order.

The opportunities for informal discussion between sessions were greatly appreciated, and one left with an accurate picture of the whole of the field of physics teaching that lies outside the universities, and also encouraged by the zeal with which the resources for the recruitment of the nation's scientific man-power are being marshalled. G. R. NOAKES

[1] Clarke, N., *J. Sci. Instr.*, **26**, 50 (1949).

CLIMATIC RACES OF *ACHILLEA*

PART 3 of the "Experimental Studies in the Nature of Species" (the "Environmental Responses of Climatic Races of *Achillea*", by J. Clausen, D. D. Keck and W. H. Hiesey, Carnegie Institute of Washington Publication 581, 1948) is a worthy member of a remarkable series of researches which is rapidly casting a flood of light on the dynamics of evolutionary processes. Starting with Turesson's concepts of ecotypes, etc., and from his simple technical approach to the detection of physiological subdivisions within the lowest taxonomic units, the effective collaboration of three very different members of a powerful team, amplified by the natural resources of California, have developed a series of refined techniques for revealing evolution in action in a way which has not been attempted elsewhere.

As in Turesson's original investigations the first step in these studies is always the close comparison of samples of different populations of a species, derived from different ecological or climatic habitats, under the uniform conditions of an experimental garden by means of which genetically determined differences can be separated out from temporary modifications imposed from without. *Achillea* is shown to be a very favourable experimental object for this purpose owing to its exceptionally wide geographical and climatic range, as well as to its ease of cultivation and prolific growth. By the skilful application of statistical methods to an enormous wealth of material the existence of very many significantly different types of populations is demonstrated both on a transect across California from the coast inland over the coastal ranges and Sierra Nevada, which lays the emphasis on altitude, and also on a latitudinal transect up the American continent from California to Alaska and in a limited amount of material from Europe. Local populations are shown to be mixtures of biotypes, the composition of the mixture varying somewhat in neighbouring populations within the same climatic belt. A distinct zonation of biotypes nevertheless always occurs in passing from one climatic belt to the next; this makes it possible to distinguish climatic races. A few of the characters by which biotypes are distinguished are morphological (height, leaf textures, etc.); but far more commonly they are physiological, involving characters such as growth-rate, length and timing of dormant periods, date and duration of flowering, frost or drought sensitivity, etc.

The next step in the inquiry here, as in the previous studies, is the close comparison of clones of selected biotypes in each of three transplant stations (Stanford, Mather and Timberline), representing the range of available altitudes in the same latitudinal belt. From this the adaptive significance or otherwise of the observed differences can be tested. In the event it is very clearly shown that an unmistakable equilibrium exists between habitat and population. Many compromises are tolerated in individual cases in which lack of fitness in one character may be compensated by the possession of some other; an example quoted is the counteraction of the ill-effects of frost sensitivity in an alpine habitat by means of precocious fruiting. On balance, however, each population is found to be better suited to its own environment than to others, a condition which seems to point unmistakably to natural selection acting in a strictly Darwinian sense.

A third technique which is introduced here for the first time is the further analysis of the individual physical and physiological factors involved in the selection process by the comparative study of clonal material of selected biotypes under exactly controlled greenhouse conditions. At different temperatures, light intensities and lengths of day, clear-cut differences of reaction could be uncovered between selected biotypes from which some insight could be gained into the significant physiological factors (minimum light requirements, rates of photosynthesis, etc.) involved in the climatic reactions. These have not yet been further analysed to reveal their genetical make-up; but if such analysis can be provided *Achillea* is likely to become the best example yet investigated for revealing in detail the mode of operation of climate in inducing subspecific differentiation in a plastic species.

It is the authors' opinion that the development of many climatic races is necessary to the attainment of a wide geographical range. This is certainly often the case, though whether *Achillea* is an extreme example is not quite so clear. It is likewise often the case that the attainment of a wide geographical range

precedes the splitting up of a species into others, and to this extent we may feel that we are witnessing in *Achillea* not micro-evolution only (to use the name coined by Goldschmidt) but a phase of macro-evolution also. That it is a phase only and not necessarily the whole story of macro-evolution the authors themselves would probably be the first to admit. The facts so far ascertained for *Achillea* are, however, a salutary reminder that evolutionary trends are not wholly directed by factors internal to the organism, as some evolutionists, in reaction against simple Darwinism, have recently tended to think, and for this purpose alone, therefore, this work merits close attention.

I. MANTON

TREASURY GRANTS FOR SCIENCE AND RESEARCH IN GREAT BRITAIN

AMONG the items of interest to scientific workers in the Civil Estimates for 1949–50, Class I, Central Government and Finance, may be noted £32,625 for the Central Economic Planning Staff, the staff of which is reduced from 28 to 24, and £23,787 for the Economic Information Unit, the staff of which is increased from 13 to 22. The Organisation and Methods Division of the Treasury has also been expanded with a staff of 79 as against 57 in the previous year and with a vote of £71,706 in place of £51,733.

For the Government Chemist £188,061 is required, an increase of £16,333, while the estimate for the Office of the Lord President of the Council is practically unchanged at £19,200, in spite of an increase of 4 in the scientific staff. The Estimates for Class IV (Education and Broadcasting) include £144,091 for the Science Museum as against £132,443 in 1948–49, £275,712 for the British Museum, a net decrease of £8,215, £215,315 for the British Museum (Natural History), a net increase of £17,666, and £14,150,000 for broadcasting, a net increase of £450,000. Estimates of £3,370,868 for science and the arts include £43,500 for the Royal Society (£20,000 for scientific investigations and £17,250 for scientific publications), £40,500 for the National Library and £41,000 for the National Museum of Wales, £22,500 for the National Central Library, £1,618,000 for the Medical Research Council, of which £369,000, or the bulk of the increase of £483,000, is for the erection and structural adaptation of buildings and the purchase of special equipment, including a cyclotron, £777,000 for the Agricultural Research Council (an increase of £327,000), £100,000 for Nature Conservancy, £575,000 for the Arts Council of Great Britain and £46,000 for the British Film Institute. With £2,000 for the Royal Society of Edinburgh and £3,000 for the Solar Physics Observatory the estimates for research and development under Class IV, Science and the Arts section, amount to £2,543,500.

An appendix to the Estimates sets forth the other amounts provided for research and development in the Estimates for 1949–50 and totalling £96,072,533. This includes £6,632,000 for scientific services in the Navy Estimates, as well as £2,758,000 under shipbuilding repairs, maintenance, etc., and £481,000 under Works, Building and Repairs at Home and Abroad. Under Class II, there are £35,765 for Commonwealth Economic and Research Services, £10,000 for the National Institute of Oceanography, and £950,000 for Development and Welfare (Colonies, etc.) Research Schemes. Research and testing under the Ministry of Fuel and Power are estimated at £226,600, while Class VI also includes £1,240,970 for agricultural, fishery and shell-fish research, £139,300 for forestry research, and £424,807 for the Development Fund. For the Department of Scientific and Industrial Research the net amount is £4,199,625, and for agricultural research under the Department of Agriculture for Scotland, £500,021. Under the Ministry of Works, the estimate for scientific and research establishments, etc., amounts to £918,685, and miscellaneous items bring an estimate of £54,800,000 for research and development under the Ministry of Supply to a total of £74,473,000.

For the Universities and Colleges, etc., of Great Britain, £17,671,500, an increase of £5,168,500, is provided, including a loan of £75,000 for housing accommodation for staff and £32,000 for postgraduate studentships in Oriental, Slavonic, East European and African studies. Non-recurrent grants represent £4,750,000, and of the remainder £8,482,853 is for English Universities, £504,200 for Wales and £1,538,537 for Scottish Universities. In addition to those grants made on the recommendation of the University Grants Committee, there are a number of grants for specific purposes made to individual universities by different Departments or bodies, and these are given in an appended schedule.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 11

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. R. F. I. Bunn: "The Manorial Halls of Manchester, 1515–1839".*

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—"North-West Iran To-day" (Kodachrome films with commentary by Sir Clarmont Skrine).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. W. Muckle: "Experiments on a Light Alloy Model Superstructure".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Scheme for the Interchange of Information on Electrical Engineering Laboratory Practice" (to be opened by Dr. E. Bradshaw) and "Transient Display Apparatus" (to be opened by Mr. A. C. Normington).

Tuesday, April 12

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Frank Stockdale, G.C.M.G.: "Colonial Development".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. W. C. Fergusson: "Polytetrafluorethylene".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. R. H. Barfield: "Radio-Frequency Heating".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. H. R. Mills and Mr. R. J. Love: "The Fatigue Strength of Cast Crankshafts".

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mrs. E. D. Pugh: "In and Around Madras".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Dr. G. R. Davies: "Chromatography".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.30 p.m.—Mr. D. O. Walter: "Some Metals and Alloys for the Instrument Designer".

Tuesday, April 12—Thursday, April 14

FARADAY SOCIETY (in the Department of Physics, The University, Bristol).—General Discussion on "Crystal Growth".

Wednesday, April 13

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1.10 p.m.—Mr. R. F. Tredgold: "What People Think of Leadership".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. S. G. Daniel: "The Viscosity of Aero-Engine Oils at Low Temperatures".

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH CENTRE (at the Heriot-Watt College, Edinburgh), at 7 p.m.—Annual General Meeting: Discussion on "Fundamental Principles of Electrical Engineering—How and When should they be Taught?" (to be opened by Prof. M. G. Say).

Thursday, April 14

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (joint meeting with the INSTITUTION OF ELECTRONICS, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Dr. J. W. T. Strange: "New Developments in Fluorescent Lighting".

INSTITUTE OF WELDING, NORTH LONDON BRANCH (at the Polytechnic, Regent Street, London, W.1), at 7.30 p.m.—Annual General Meeting.

Friday, April 15

INSTITUTE OF NAVIGATION (at the Royal United Services Institution, Whitehall, London, S.W.1), at 5 p.m.—Mr. A. J. Hughes: "The Influence of Echo Sounding".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR ASSISTANT IN THE CHEMISTRY DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (April 16).

SENIOR ASSISTANT IN PHYSICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (April 16).

UNIVERSITY LECTURER and a UNIVERSITY DEMONSTRATOR IN GEOGRAPHY—The Secretary, Appointments Committee of the Faculty of Geography and Geology, Department of Mineralogy and Petrology, Downing Street, Cambridge (April 19).

ASSISTANT SECRETARY (competent administrator with some training in archæology)—The Secretary, Council for British Archæology, c/o Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1 (April 19).

DEMONSTRATOR IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 19).

SENIOR ASSISTANT TEACHER OF TELECOMMUNICATIONS ENGINEERING for the City and Guilds Final Certificate and British Institute of Radio Engineers' graduateship examinations—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (April 20).

ELECTRONICS ENGINEER and a CONTROL ENGINEER in the new Nuclear Physics Laboratory—The Registrar, The University, Liverpool (April 20).

LECTURER IN PSYCHOLOGY—The Secretary, Queen's University, Belfast (April 20).

KEEPER OF BIOLOGY in the City Museum—The Director, City Museum, Park Row, Leeds 1 (April 21).

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS, for work on the physics of metals in Ministry of Supply Research and Development Establishments in London and South England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1190/48A (April 23).

TECHNICAL ASSISTANT IN THE DIRECTORATE OF ORDNANCE FACTORIES (Filling) under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.911/48A (April 23).

LECTURERS IN THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT, and LECTURERS IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (April 23).

ASSISTANT LECTURER IN PURE MATHEMATICS, an ASSISTANT LECTURER IN APPLIED MATHEMATICS, and an ASSISTANT LECTURER (temporary) IN MATHEMATICS—The Registrar, University College, Singleton Park, Swansea (April 23).

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER in the Fuel Research Organisation of the Department of Scientific and Industrial Research, to take charge, under the Director of Fuel Research, of investigations in relation to the measurement of atmospheric pollution and the factors affecting the nature, intensity and distribution of pollution—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2483 (April 27).

SENIOR SCIENTIFIC OFFICER to take charge of an out-station of the Fuel Research Organisation of the Department of Scientific and Industrial Research shortly to be established at East Kilbride, near Glasgow, and an EXPERIMENTAL OFFICER (Chemist) for work including the sampling and analysis of solid, liquid and gaseous fuels, and participation in the testing of appliances—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2485 (April 27).

PRINCIPAL SCIENTIFIC OFFICER, to take charge of the Seed Testing and Plant Registration sections, a PRINCIPAL SCIENTIFIC OFFICER in Entomology, to take charge of newly formed section, and an EXPERIMENTAL OFFICER to assist in potato work, at the Department of Agriculture for Scotland Seed Testing, Plant Registration and Plant Pathology Station at East Craigs, Corstorphine, Edinburgh—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2481 (April 28).

PHYSICISTS and MATHEMATICIANS for duties concerned with aerodynamics, armaments, ballistics, crystallography, fuels, heat, jet propulsion, radio and radar, and X-rays, in Ministry of Supply Research and Development Establishments in Southern England and the South Midlands—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.398/48A (April 30).

ENTOMOLOGIST for research and advisory work on the control of insect pests of wattle, and a PLANT PHYSIOLOGIST for research on the physiology and biochemistry of tannin formation in wattle bark, and the study of pathological conditions of wattle believed to be of physiological origin, at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 30).

LECTURERS IN THEORETICAL PHYSICS AND APPLIED MATHEMATICS and in EXPERIMENTAL PHYSICS, a LECTURER IN ENGINEERING MATHEMATICS (including pure and applied mathematics and mathematical physics), a LECTURER IN ELECTRONICS, and ASSISTANT LECTURERS IN THEORETICAL PHYSICS, APPLIED MATHEMATICS, EXPERIMENTAL PHYSICS, and ELECTRONICS—The Secretary, The University, Aberdeen (April 30).

SENIOR LECTURER or LECTURER IN CYTOLOGY, and a SENIOR LECTURER or LECTURER IN GENETICS—The Registrar, The University, Manchester 13 (May 7).

MECHANICAL and AERONAUTICAL ENGINEERS (Senior Scientific Officer grade) at Royal Aircraft Establishment, Farnborough, and other establishments in South England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.882/48A. (May 7).

SENIOR SCIENTIFIC OFFICER (Physicist) (Ref. A.403/48A) to lead a group of physicists and engineers studying effect of tropical conditions on Service materials and equipment, and a SCIENTIFIC OFFICER (Chemist) (Ref. F.429/48A) to work on analytical or biochemical investigations into deterioration of equipment under tropical conditions, at the Tropical Testing Establishment, Nigeria—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (May 9).

LECTURERS IN ENGINEERING—The Secretary, The University, Aberdeen (May 9).

LECTURER IN ENTOMOLOGY at Rhodes University College, Grahamstown—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 15).

RESEARCH CHAIR IN AGRICULTURAL ECONOMICS at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, May 15).

LEVERHULME STUDENTSHIPS (2) IN CHEMICAL ENGINEERING—The Secretary, University College, Gower Street, London, W.C.1 (May 15).

CHAIR OF PHYSICS at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 18).

DEMONSTRATOR IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (May 23).

ASSISTANT DIRECTOR OF THE GAME AND TSETSE CONTROL DEPARTMENT of the Government of Northern Rhodesia—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ASSISTANT IN SCIENTIFIC INFORMATION SECTION—The Secretary, Gas Research Board, The Abbey, Beckenham, Kent.

DEVELOPMENT ENGINEERS, CHEMISTS and PHYSICISTS, to undertake development work aiding the design of new plant, to operate prototype plant and to suggest and try out improvements—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

STUDENT TECHNICIAN IN THE DEPARTMENT OF CHEMICAL PATHOLOGY—The House Governor, St. Mary's Hospital, Paddington, London, W.2.

ELECTRICAL ENGINEER to undertake the layout of distribution systems for large factories involving step down from high voltage grid intake to medium voltage factory Sub-stations at various load centres and on the low voltage motors, etc.—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

HONOURS GRADUATES (preferably in Zoology) to carry out research projects on (*a*) nutrition, including the design of an adequate artificial diet, and (*b*) behaviour of locust hoppers—The Director, Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, London, S.W.7.

METEOROLOGICAL OFFICERS and ASSISTANT METEOROLOGICAL OFFICERS in the Malayan Meteorological Service—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ANALYST IN THE DEPARTMENT OF CHEMISTRY, to undertake the examination of soils, fertilizers, feeding-stuffs, dairy products, insecticides, etc.—The Registrar, The University, Nottingham.

PHYSICISTS and METALLURGISTS for work on surface phenomena metallurgy of coating processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'X-Ray'.

LABORATORY TECHNICIAN FOR THE PHYSIOLOGY DEPARTMENT—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

LECTURER (Grade I) IN THE DEPARTMENT OF MATHEMATICS—The Secretary, Royal Technical College, Glasgow.

LABORATORY TECHNICIAN—The House Governor, Coventry and Warwickshire Hospital, Coventry.